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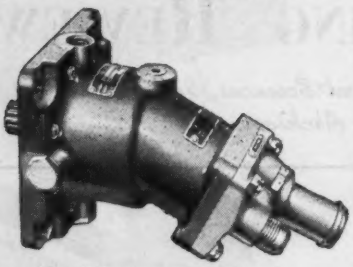

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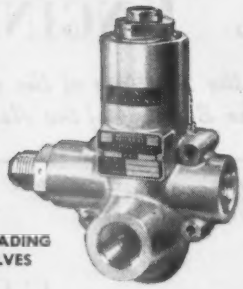

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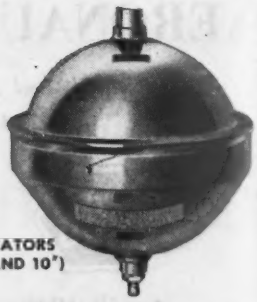

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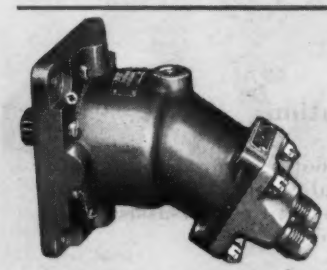

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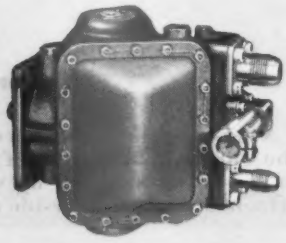

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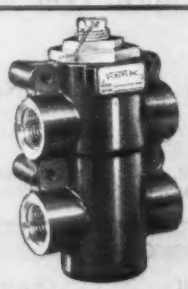

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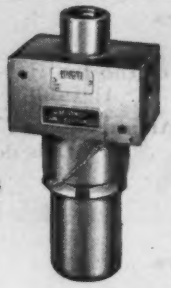

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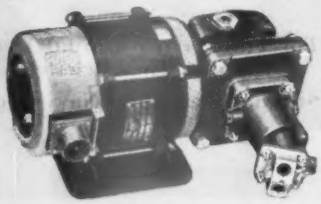

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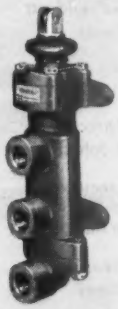

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The Fourteenth Annual Meeting of the Institute of the Aeronautical Sciences

ALEXANDER KLEMIN

Consulting Engineer

Introduction

THE TECHNICAL SESSIONS of the Fourteenth Annual Meeting of the Institute of the Aeronautical Sciences were held in the Pupin Physics Laboratories Building of Columbia University, New York, January 29, 30, and 31, 1946.

Because of the termination of the War, a partial lifting of restrictions permitted the disclosure of some new developments in all fields of aeronautics, but many new advances could not be reported.

While travel and hotel difficulties prevented many members and guests from attending the meetings, a total of over 1,500 persons attended the 13 technical sessions. The attendance at the Aerodynamics, Aircraft Propulsion, and Rotating Wing Aircraft sessions made it necessary to transfer these meetings to larger rooms.

Aerodynamics

The Aerodynamics Session confirmed the view that a retractable aileron permits the use of a full-span flap. The most important papers dealt with compressible flow. The theory of flow at high Mach Numbers is still tentative, still mainly empirical, but the papers presented gave promise of enough information for engineering purposes. It was important to learn also that with the aid of a retractable aileron a full-span flap can be employed. From a paper on the theory of tailless airplanes there appeared some hope of securing higher directional and yawing stability in this type of aircraft. The veil of secrecy was lifted partially from the aerodynamics of internal flow, in relation to ducts and radiators.

Full-Span Wing Flaps

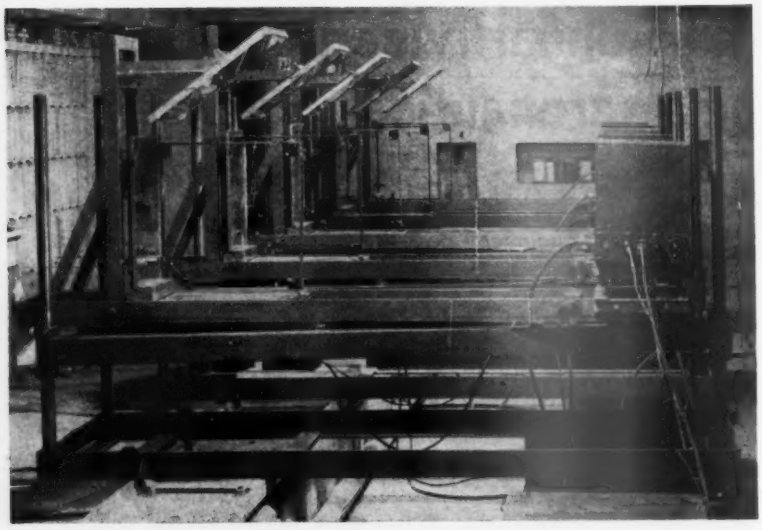
In spite of increased wing loadings, the use of full-span wing flaps has been delayed because of inability to find a suitable aileron. "The Development of a Lateral-Control System for Use with Large-Span Flaps," by I. L. Ashkenas (Supervisor of Aerodynamics Northrop Aircraft, Inc.) outlines the various steps in the aerodynamic development of a retractable aileron system well adapted to the full-span flap and successfully employed on the Northrop P-61 airplane. Included is a discussion of the basic data used, the design calculations made, and the effect of structural and mechanical considerations. Changes made as a result of preliminary flight tests are discussed and the final flight-test results are presented. It is concluded that the use of this retractable aileron system has, in addition to the basic advantage of increased flap span, the following desirable control characteristics: (a) favorable yawing moments; (b) low wing torsional loads; (c) increased effectiveness for the landing configuration; (d) small pilot forces, even at high speed.

Greene's Equation

Greene's equation for compressible flow is based on mathematical work that has been severely attacked on the ground that it represents empirical modification of equations, rather than rational processes. But the fact remains that Greene's attenuation theories do somehow produce formulas that match up with experimental results. George L. Shue (Aerodynamics Engineer, Consolidated Vultee Aircraft Corporation) therefore takes the position that the attenuation theories may be applied in practical design and acts on this premise in "Additional Developments of Greene's Equation to the Study of Compressible Airflow" where Greene's method is extended to supercritical conditions. This extension is the result of integration of Greene's equation beyond the critical conditions. The correction which is then applied to the airfoil incompressible pressure coefficient predicts supercritical conditions downstream of the peak negative incompressible pressure. The calculated position of the shock that accompanies the return to subsonic conditions is shown to progress downstream with increasing Mach Number. The calculated chordwise pressure distribution checks with high-speed test data, and this automatically brings the lift and pitching moment values into agreement with test results. The energy loss in the shock yields a reasonable means for calculating the increase in drag at high speeds. Each surface of the airfoil with its appropriate critical Mach Number is treated separately in estimating the drag. Mr. Shue's paper includes several equations that should be highly valuable in practical corrections of drag, lift, and local pressures at high Mach Numbers.

Ballistic Contributions

Just a few years ago the aerodynamics of the airplane and the theory of ballistics were wide apart. But with the advent of jet propulsion and guided missiles, the gap closes and a paper on "Ballistic Constributions to Aerodynamics," by Alexander C. Charters (Ballistic Research Laboratory, Aberdeen Proving Ground), appears entirely logical. It is hardly possible to improve on the writer's abstract. "A systematic study of projectile aerodynamics has been made in the spark photography range of the Ballistic Re-



Aerodynamics range: photograph looking up-range showing first group of five stations. (From *Ballistic Contributions to Aerodynamics.*)

search Laboratory and the results on drag are now sufficiently complete to have general application to compressible flow problems. The performance of conical heads is analyzed by the first order theory and by the theory of Taylor and Maccoll, extended to additional cone angles. An empirical formula representing the variation of drag coefficient with Mach Number is presented. The quantity $\sqrt{1 + K_D M^2}$ is shown to vary linearly with M at supersonic speeds for a wide variety of projectile shapes. Results on the length of boattailing are given. For a fixed boattail angle, it is shown that the drag coefficient decreases linearly with base area, that the side and base pressures are constant and independent of boattail length; and that their difference is proportional to the slope of the linear function. The effects of banding, scale (size), interaction of head on base, and skin friction are discussed briefly.

"Application is then made of these ballistic results to the design of a supersonic aircraft fuselage shape giving minimum drag, with a fixed body diameter and with the arbitrary choice of a conical head and conical boattail. A 50″ diameter fuselage at 50,000 feet and a 20 mm model at sea level are considered. It is found that the design and performance of the two are very similar, with the optimum head angle (semivertex) being near 4°. At a Mach Number of 1.5 base pressure and skin friction are nearly equal and account for over 85% of the drag. As the Mach Number is increased to 5.0, the skin friction alone accounts for 75% of the drag. The boattail is found to effect a saving of 23% or more in drag, even at a Mach Number of 5.0. The power required for the 50″ fuselage flying at a Mach Number of 1.5 is computed to 2,263 h.p. at 50,000 feet, which increases to the impractical figure of 21,243 h.p. at sea level."

We can add to this abstract a few pertinent notations. The spark photography range at the Ballistic Range is being used successfully for a program of research of the aerodynamics of projectiles in free flight. The program has already gone far enough to permit the formulation of empirical laws for (1) the variation of drag coefficient with Mach Number ($M > 1$), (2) the effect of boattail length on the drag, and (3) the effect of banding on drag. These laws combined with theoretical calculation for head pressure and skin friction are adequate to compute the drag of certain simple types of projectiles at supersonic velocities. The head shape has been dealt with more effectively by aerodynamic theory than any other of the projectile's components. The developments in the theory to date leave a great variety of head shapes untouched. However, the exact solution of an infinite cone is a skeleton on which the characteristics of many of the unsolved shapes can be based. The optimum head shape giving minimum drag *for a fixed head length* is probably different from a cone. Von Kármán's theory gives a shape that has a blunt point. This may not be far from the truth, however. Some firing tests have been carried out with a series of ogival heads and with heads with different meplats, and some elementary calculations have been made to determine the optimum meplat diameter for a conical head. The firing tests and calculations indicate that the optimum shape for minimum drag will not be far from the shape consisting (1) of a secant ogive with twice the radius of the tangent ogive and (2) of a rounded meplat with a diameter of about 0.1 caliber. There is now a Q function which relates KD to M. The equation is

$$\sqrt{1 + KDM^2} = a + bM$$

Thomas designated the quantity $\sqrt{1 + KDM^2}$ by the letter Q and tested the fit of the Q function to the drag coefficient functions of all the standard projectiles, types 1 through 8. The fit of the Q function to the experimental data is remarkable. Boattail is a new word to airplane people. Its discussion is interesting. Projectiles are the supersonic twins of dirigibles, overlooking, for the moment, differences in the conventional methods of stabilization. The rear portion of a dirigible body is closed by a gentle curve to avoid separation of the airflow and the high drag that accompanies a large wake. A similar attempt is made to streamline the rear of a projectile by adding behind the body a section tapered to the rear. This section, which is usually the frustrum of a cone, is called the boattail. Ordnance engineers have held the opinion that the advantages of boattailing are outweighed at supersonic speeds by improvements in the head shape, since the overall length is ordinarily limited by the stability available from the twist of rifling in standard guns. Consequently, most artillery shells are either square based or have only a short section of boattail. The design of the supersonic aircraft fuselage carried through in the body of the paper deserves the most careful study.

Internal Flow Systems

F. R. Rogallo (Langley Memorial Aeronautical Laboratory, N.A.C.A.) discusses the important subject of "Internal Flow Systems for Aircraft." The ideal aerodynamic characteristics of aircraft-radiator installations have been determined by a consideration of the radiator as an actuator disc operating on a perfect fluid. In the treatment by Meredith the cooling system was assumed to be operating in previously undisturbed fluid. Because it is often necessary and may sometimes be aerodynamically advantageous to deviate from that condition in actual installations, an extension of the previous theory was considered desirable. In the present investigation, simple equations are derived for the calculation of the drag, the pressure characteristics, and the efficiency of internal flow systems either isolated or in combination with propellers, wings, or fuselages. These equations cover the range of outlet velocities from zero to above that of the free stream. Experimental data obtained in a 5-ft. vertical wind tunnel are presented to verify the theory. The complete and scholarly paper deserves careful study. Aircraft designers, as is so often the case, will turn at once to the excellent design recommendations. The inlet opening of an internal flow system that tends to decrease the final velocity of the air flowing through it should, if practicable, be located at the forward stagnation point of some portion of the aircraft. The results of the present investigation indicate that openings so located may incur negligible losses, but no satisfactory inlet openings for other locations were developed. The investigation showed that small openings may cause relatively large losses; it will probably be found desirable to employ a common inlet opening for two or more systems when possible.

It is recommended that, whenever practicable, the inlet opening of a velocity-decreasing system be located in the highest total-pressure region of the propeller slipstream. Such a treatment promises more effective cooling on the ground and in climb, and a small increase in efficiency at cruising and top speed.

Unnecessary duct losses should be carefully avoided. Such losses will generally entail additional wake losses. Many references pertaining to duct design are available, the gist of which may be condensed into the following general principle: Avoid high velocities and abrupt changes of the shape or the area of cross section except at the outlet. Butterfly valves or other throttling devices within the ducts or at the inlet should be avoided. Regulation at the outlet is practicable and efficient. Leakage should be eliminated because it will generally cause large increases in airplane drag. It appears desirable to test all internal flow systems, including the airplane cabin, for leakage.

For the minimum power-loss coefficient of an outlet opening, the hypothetical jet velocity should be the same as that of the potential flow at the location of the opening (that is, $K_0 = 1$). When the outlet velocity is considerably below the optimum, which may be the result of large pressure losses within the system, it may be advantageous to install a blower.

On pusher-propeller installations it appears desirable to locate the outlet openings of velocity-decreasing systems ahead of the propeller in order to increase the propulsive efficiency. This recommendation is not limited to internal flow systems, but its desirability in connection with bodies such as wings or fuselages is already well known. Additional research on pusher-propeller arrangements appears desirable.

Many internal flow systems tend to increase the final velocity of the air flowing through them. Such systems assist in propelling the aircraft and may therefore be considered as a part of the propulsive system. Similar to propellers, systems of this type may be most efficient when located in the wake of velocity-decreasing systems, including wings and fuselages; a narrow-slot inlet opening in a region of relatively thick boundary layer appears promising and should be further investigated. When the required quantity of air is large relative to the quantity that can be obtained from the boundary layer, however, an inlet located at a forward stagnation point will probably be found to be the most efficient.

The outlet velocity of a propulsive system will seldom be appreciably less than that of the free stream. In general, therefore, the outlet shape and location should be such that the jet will not impinge on the external surfaces of the aircraft.

Thin Airfoils

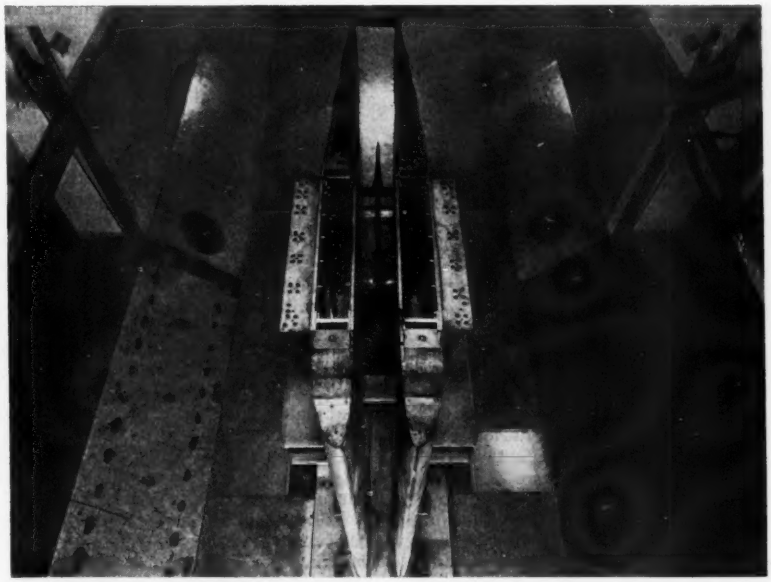
The paper by Allen E. Puckett (Chief, Wind Tunnel Section, Jet Propulsion Laboratory, California Institute of Technology), "Supersonic Wave Drag of Thin Airfoils," shows the possibility that the wave drag of supersonic speed may be reduced by an appropriate plan form given to the wing, by giving the wing such a sweepback that the leading edge and maximum thickness line of the wing lie behind the front of the Mach wave created on the centerline of the wing. Thus practical results may be obtained from a highly theoretical investigation. The objective of the paper is well defined. "A finite body moving in a non-viscous compressible fluid, at a speed greater than the speed of sound, will experience a drag, generally called "wave" drag. This drag may be computed in special cases by assuming that the disturbance velocities produced by the body are small compared to the velocity of the body. With this assumption of small perturbations, the equations of motion for the fluid may be linearized, and solved fairly easily. This was done by Ackeret for two-dimensional thin airfoils (i.e., infinite span). For slender symmetric bodies, the solution was given by von Kármán and Moore. At the suggestion of Th. von Kármán, the methods have been extended to the case of a three-dimensional body which is very thin in one dimension, such as an airfoil." The paper itself indicates that the process can indeed be applied to a thin three-dimensional airfoil by means of a superposition of elementary solutions to the linearized equations. The method is applied to the computation of the wave drag at zero lift of a triangular or "delta" wing. The particular case of a delta wing with double wedge cross section is considered. It is found that the drag will depend critically upon the position of the leading edge and the line of maximum thickness relative to the Mach wave. If both of these lines lie well behind the Mach wave, the drag coefficient may be one-half or less times the drag of a two-dimensional wing of the same thickness. The optimum location for the point of maximum thickness is found to be near the quarter chord point. Curves of drag coefficient as a function of leading edge angle and location of maximum thickness point are given.

Wing Section Development

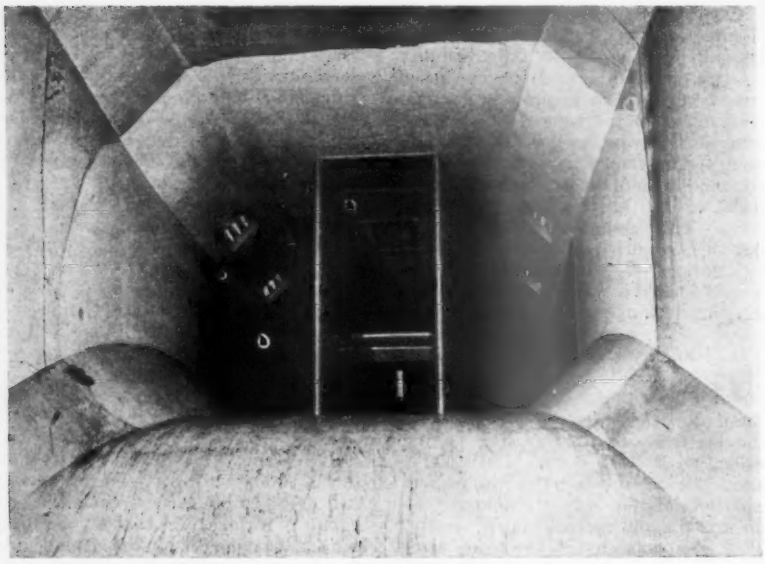
George S. Schairer (Chief Aerodynamicist, Boeing Aircraft Company), writing on "Systematic Wing-Section Development," points out that the airplane designer has a large number of tested airfoils to choose from. It would seem that the field should be well covered and little room for improvement remains. Mr. Schairer holds that such a view is incorrect and that there is still much to be learned about the behavior of airfoils, and that a good deal can still be done to help the airplane designer in the selection or modification of an airfoil. In an early part of the paper a typical set of airfoil data as measured in a two-dimensional wind tunnel is presented. These data are analyzed to show how a few tests can be used to indicate the characteristics of many airfoils. The data which are sometimes available may include:

(1) Two-dimensional wind-tunnel data giving lift, drag, and moments at one or more Reynolds Numbers.
(2) Pressure distributions for (1).
(3) Data at various Mach Numbers.
(4) Pressure distributions for (3).
(5) Effects of surface condition and turbulence on characteristics.
(6) Three-dimensional test data on wings incorporating the airfoil.

The author's remarks on compressibility are especially valuable. He suggests that compressibility characteristics can be evaluated very well in



Top view of high-speed two-dimensional test section with tunnel top removed. (From *Systematic Wing-Section Development.*)



Test section of Boeing wind tunnel with end plates for testing 2-ft. chord, 3-ft. span airfoils. (From *Systematic Wing-Section Development.*)

most cases from two-dimensional tests. Excellent agreement has been found in several cases where two-dimensional force data were compared with three-dimensional force data. When the three-dimensional test conditions are not favorable, better results can be obtained two-dimensionally, as where the three-dimensional model results are badly affected by blocking. It is of interest to be able to predict the compressibility characteristics. Using the relationship by von Kármán for the critical Mach Number (Mach Number for attainment of supersonic flow), it is possible to compute Mach Numbers for which supersonic flow is just attained. Using the von Kármán-Tsien relationship to predict the critical Mach Number and the Glauert relationship to compute lift coefficient, it is possible to obtain estimates of the critical Mach Number and the lift coefficient at that Mach Number corresponding to a given low-speed pressure peak and lift coefficient. A convenient chart for making such calculations is developed. For each low-speed pressure peak value there will be a critical Mach Number in accordance with the von Kármán-Tsien relationship. At this Mach Number the lift coefficient is increased over the low speed value by the Glauert relationship. In the application to an airplane, it is speeds and wings loadings that are of interest and not Mach Numbers and lift coefficients, put Mach Numbers can be easily converted to speed with the use of charts. The charts presented by the author give a unique method of evaluating the critical Mach Number and speed at the altitude chosen. Some quotations are pertinent.

"It is interesting to note that in some cases the constant lift (M^2C_L) lines cross the airfoil data at two points. There is a high speed above which supersonic flow is obtained and a low speed below which it also occurs. The meaning of this is of great importance for it can be seen that there is a wing loading above which supersonic flow will occur regardless of speed. This method permits the determination of speeds at which supersonic flow should occur. These critical speeds are not necessarily related to the speed at which the drag starts to increase or to the stability critical speed. Actually the drag starts to rise at about the point where supersonic flow starts. This drag rise comes about not only because of the shock where the flow attempts to become subsonic again but also because of separations in the flow. The pressure gradients are increased by Mach Number and if separation is imminent this can cause a drag rise without the existence of supersonic flows. If separations are not likely, there may be no drag rise at all up to the point where supersonic flow starts. The method for obtaining two-dimensional airfoil data at high Mach Numbers varies between various experimenters. An unusual method has been used by the Boeing Aircraft Company in their wind tunnel at Seattle. Two walls six inches apart are mounted vertically in the test section giving a test section 6 inches in span by 96 inches high. When six inch chord airfoils spanning the jet are tested in this tunnel the blocking is very small, permitting tests of 10 per cent thick airfoils to speeds above 0.92 Mach Number. The velocity between the walls is very uniform at all speeds and is about 50 per cent higher between the walls than in the tunnel proper. Lift, drag, and moment are measured on the force balance. The drag is also measured by wake survey."

The rest of the paper discusses the relationship of the airfoil to the design of an airplane, structural strength, rigidity, internal volume required for fuel, etc. Discussing landing gear and flaps we read "The landing gear is frequently housed in the wing. This will often place severe limits upon the airfoil profile if the gear is to be held within the normal wing surface. Usually a compromise is reached with portions of the landing gear protruding from the wing contour. The problem is more serious with wing flaps where the wing contour is usually chosen so as to contain all or nearly all the flap mechanism. Hollowness of either the upper or lower surface contours frequently works great hardships upon the flap mechanism." Further on the paper relates the airfoil to the aileron and its special requirements, to flutter, deicing, and stalling. The whole constitutes an excellent survey of the way in which aerodynamics can be "practically" utilized for design purposes.

Wing-Tip Fins

The tailless airplane has long been attractive to designers, because of its simplicity and possibility of greater aerodynamic efficiency. This type is all the more important today because it lends itself so well to the application of jet engines. Its use has been retarded by problems in directional and yawing stability. Hence, the mathematically rigorous paper by Dr. Maurice A. Garbell (Consultant in Aeronautical Engineering and Meteorology) on "Theoretical Principles of Wing-Tip Fins for Tailless Airplanes and Their Practical Application" is timely. The paper compared the relative merits of wing-tip fins and central vertical fins in their contribution to the static directional stability, side force, and rotary damping in yaw derivatives of tailless aircraft. A detailed analysis revealed the manner in which the lift and drag of wing-tip fins concur in producing stability and damping. The measure in which toed-fins increase the fin effectiveness and the useful stable range of angles of sideslip is critically viewed with particular consideration to the drag penalty induced by this arrangement. The effect of wing sweepback on the various types of fin configurations was examined. The difficulty in obtaining adequate fin effectiveness on wings without sweepback, especially if the fin drag constitutes a critical design factor, was presented. While a paper of this type must be read in detail to be appreciated, there are certain conclusions of the author which can be usefully brought out from their context: Since static longitudinal stability may be achieved without a tail by employing a wing with a positive pitching moment coefficient about the aerodynamic center and by locating the airplane center of gravity ahead of the wing aerodynamic center, the only penalty incurred through the omission of the horizontal tail is a reduction of the rotary damping in pitch of the aircraft by approximately 75 per cent. A comparison of the moments of inertia shows that a similar reduction of 75 per cent or more is attainable through careful design and weight allocation, so that the nondimensional damping-in-pitch factor appearing in the biquadratic

dynamic-stability equations, which is proportional to the aerodynamic damping and inversely proportional to the moment of inertia, remains substantially the same for the tailless airplane as for conventional designs.

Similar considerations apply to longitudinal short-period oscillation, and the problem of lateral subsidence is no different from that of the conventional airplane.

Despite the exiguity of their rotary damping in yaw, tailless airplanes as a rule exhibit slightly positive or neutral spiral stability because of their small static directional stability and their comparatively large rolling-moment derivative with sideslip.

The unsatisfactory damping of the combined rolling and yawing oscillations of tailless airplanes remains as the only justifiable objection to the flying characteristics of this type of craft.

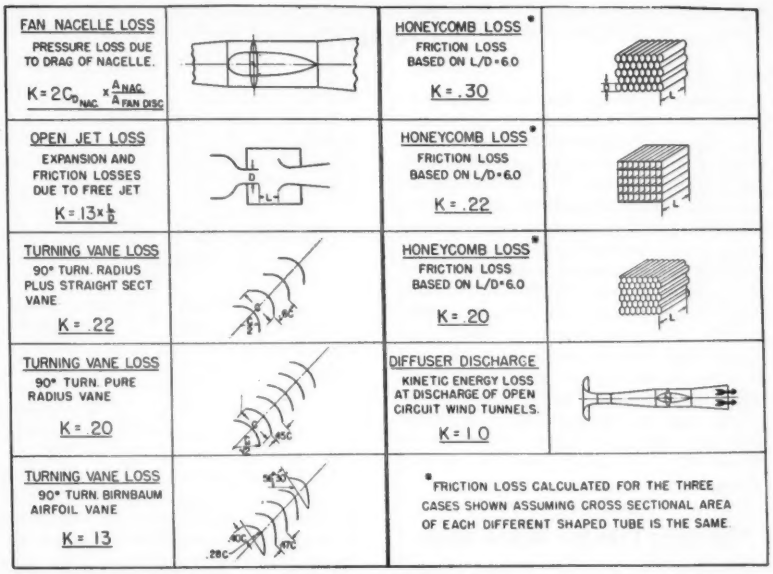
Although the oscillations are usually convergent, the large oscillatory amplitudes and the great number of complete (5–10 sec.) cycles required to damp the initial amplitude to a tolerable value have heretofore limited the usefulness of the tailless airplane. The static-directinal-stability and rotary-damping-in-yaw derivatives of most tailless airplanes are substantially smaller than those of satisfactory conventional airplanes; unfortunately, this adverse decrease in stability and damping is balanced but to a small extent by a corresponding reduction in the yawing moment of inertia, especially on multi-engined airplanes where the heavy power plants located on the wing, together with the heavy wing structure itself, are the principal contributors to the yawing moment of inertia.

Another unfavorable factor is the unbalance between the small static-directional-stability derivative and the comparatively large rolling-moment derivative with sideslip which further reduces the damping convergence of the lateral oscillations and produces the so-called Dutch Roll.

Perhaps the most important part of the paper lies in the conclusions. The newly found inwardly facing arrangement of fins with certain cambered airfoils, which offer a sharp profile-drag increase at negative angles of attack immediately below the angle of zero lift, permits the attainment of satisfactory values of static directional stability, rotary damping in yaw, and side-force slope in tailless designs with straight or sweptback high-aspect-ratio wings, and in tail-first airplanes. For tailless designs with swept-forward wings or wings with extremely low aspect ratio, the central vertical fin is maintained as being preferable.

Low-Cost Wind Tunnels

The fashion today is to build and utilize huge and fast wind tunnels. But the extremely large tunnels may entail too great expense for continuous operation and for certain types of investigation. Also, the first-class tunnels may become congested. Howard E. Roberts (Aerodynamics Engineer, Douglas Aircraft Company, Inc.) believes that the small wind tunnel may relieve the load on larger wind tunnels and expedite low priority investigations. In his paper "Considerations in the Design of a Low-Cost Wind Tunnel" he discusses such aerodynamic and design considerations as: selection of wind tunnel type, motor and speed control; evaluation of pressure losses, energy ratio and performance; flow stability and turbulence; design of fan; methods and materials of construction and cost breakdown. Specific details are given for an efficient, closed throat, open circuit, Eiffel type wind tunnel which has been in successful operation for over a year. A maximum velocity of 175 m.p.h. is obtained in the rectangular 30 by 45-in. test section with an approximate power input of 75 hp. Construction costs of this wind tunnel, exclusive of force balances, should not exceed $5,000 at present labor and material costs. Besides discussing fully and mathematically every part of tunnel design, Mr. Roberts provides excellent design charts and fine illustrations of both overall design and of detailed components.


FAN NACELLE LOSS
PRESSURE LOSS DUE TO DRAG OF NACELLE.
$K = 2C_{D_{NAC.}} \times \frac{A_{NAC.}}{A_{FAN\ DISC}}$
HONEYCOMB LOSS *
FRICTION LOSS BASED ON L/D=6.0
K = .30
OPEN JET LOSS
EXPANSION AND FRICTION LOSSES DUE TO FREE JET
$K = 13 \times \frac{1}{D}$
HONEYCOMB LOSS *
FRICTION LOSS BASED ON L/D=6.0
K = .22
TURNING VANE LOSS
90° TURN. RADIUS PLUS STRAIGHT SECT VANE
K = .22
HONEYCOMB LOSS *
FRICTION LOSS BASED ON L/D=6.0
K = .20
TURNING VANE LOSS
90° TURN. PURE RADIUS VANE
K = .20
DIFFUSER DISCHARGE
KINETIC ENERGY LOSS AT DISCHARGE OF OPEN CIRCUIT WIND TUNNELS.
K = 1.0
TURNING VANE LOSS
90° TURN. BIRNBAUM AIRFOIL VANE
K = 13
* FRICTION LOSS CALCULATED FOR THE THREE CASES SHOWN ASSUMING CROSS SECTIONAL AREA OF EACH DIFFERENT SHAPED TUBE IS THE SAME.

Values of pressure loss coefficient for various wind-tunnel components. (From *Considerations in the Design of a Low-Cost Wind Tunnel.*)

Oblique Shock Flow

As E. V. Laitone (Section Head of Flight Research Engineering, Cornell Aeronautical Laboratory) says in the introduction to his paper "Extract and Approximate Solutions of Oblique Shock Flow," the period when supersonic flow was merely of theoretical interest to aeronautical engineers has passed and supersonic wind tunnels are used extensively and designs for supersonic aircraft are being planned. The summary offered by the author reads: "The paper contains a simplified presentation of the exact and approximate solutions of supersonic flow over two-dimensional bodies." The data are all presented as a variation with the free stream Mach Number thereby enhancing their usefulness. An exact solution is given for the maximum flow deflection that can be obtained by means of an oblique shock wave at a given Mach Number. The third and higher terms are presented for the infinite series approximating oblique shock flow. The third term obtained is not the same as that originally given by Busemann in 1935 at the 5th Volta Congress. The new third term is analyzed to show that under certain conditions an oblique shock flow may be considered isentropic even though the third order of the flow deflection or pressure discontinuity is not negligible. A reliable graphical method is presented whereby the pressure distribution may be quickly and accurately obtained for a two-dimensional body in a supersonic flow field. All of the computations of this paper are based on a γ value of seven-fifths or 1.400. The thermodynamic derivations are based on the perfect gas relation $p/\rho = RT$ and the assumption that the heat transfer is negligible and the processes are adiabatic. The additional assumptions made in the analysis of shock flow are that the conditions are everywhere uniform ahead of the shock wave, that the equation of conservation of momentum may be directly applied to a stream tube passing through the discontinuity forming the shock wave, and that the loss in kinetic energy through the shock wave appears as heat energy that may be directly measured as an increase in enthalpy. The flow through the shock wave is then an irreversible adiabatic process leading to an increase in entropy. The author can be congratulated on bringing the subject to the understanding of the engineer. While the treatment is restricted to two-dimensional flow, this is no drawback since the flow over an entire wing in supersonic flight may be considered two dimensional.

Design

It cannot be said that the design sessions were indicative of the great advances now being made. But perhaps technical sessions in design should now be more concerned with technical details and auxiliaries than with broad reviews. And it is certainly worth while to know that the exhaust can be utilized for engine cooling; that inert gas can be made to protect fuel in aircraft tanks; that aircraft hydraulic motors may weigh less and occupy less space than electric motors; that low-cost structures can be designed without impairment of strength; that shock struts can be designed by a rational process; and that wings can be built whose tips will fail before the rest of the wing.

Metering Pins for Shock Struts

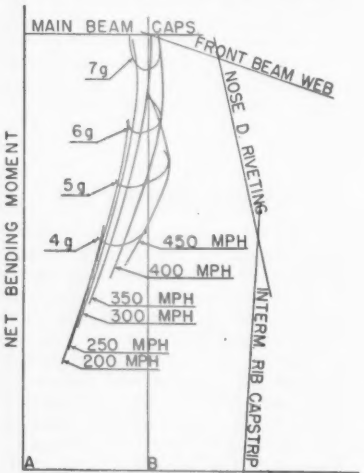
Metering pins for oleopneumatic shock struts have in the past been designed on the basis of drop tests. The "Analysis for the Design of Metering Pins for Oleo-Pneumatic Shock Struts," by E. G. Keller (Consulting Engineer, Curtiss-Wright Corporation) and H. Komm (Process Engineer, Curtiss-Wright Research Laboratory), now affords a more rational basis for calculation. The problem is one of two degrees of freedom; the coordinates of the top of the strut and of the wheel axle specify the configuration of the system. The two nonlinear differential equations of motion are derived and integrated. By this method the contour of the pin is determined for any preassigned load factor, velocity of descent, and initial pressure in the air chamber. Calculating rules are given. Checks of the theory are made against drop tests for the Lockheed Constellation and Curtiss-Wright Helldiver.

Dynamic Response Characteristics of an Airplane

A paper on "Determination of the Dynamic Response Characteristics of an Airplane Through the Application of a Sinusoidal Elevator Motion," by W. F. Milliken, Jr. (Assistant Manager, Flight Research Department, Curtiss-Wright Corporation), P. G. Kase (Curtiss-Wright Corporation), E. V. Laitone (Section Head of Flight Research Engineering, Cornell Aeronautical Laboratory), and R. C. Kidder (Curtiss-Wright Corporation), contains the theoretical background and a description of testing methods for the determination of airplane dynamic stability and control characteristics through the use of automatic control. The application of the method was discussed largely on the basis of longitudinal characteristics. The methods concerned were based on the measurement of the response of the airplane to predetermined control motions such as a sinsusoidal or exponential variation. The utility of the method was discussed, and in particular the advantages of the method at high Mach Numbers, and in the determination of the control characteristics during rapid maneuvers, were reviewed.

Strength of a Square-Tipped Wing

Leonid A. Minor (Structures Flight Research Engineer, Grumman Aircraft Engineering Corporation), in his paper on "Flight-Test Investigation of the Strength of a Square-Tipped Wing," gives this introduction to his power: "On a combat aircraft one cannot expect rigid "g" restrictions to be scrupulously observed and high positive design margins do not necessarily increase the safety of the airplane in proportion to the weight expenditure involved, unless they are distributed along the wing span in such a manner that, should a failure occur, it will not cause the total loss of the airplane. The same considerations hold true for commercial aircraft on which design load factors can be accidentally exceeded. This may occur for example under severe gust conditions. The desirability of achieving a localized failure to experiments with wing tip safety joints for the purpose of demonstrating their usefulness as a safety device. The wing of a production airplane was modified to break in symmetrical flight just outboard of the middle aileron hinge under normal accelerations corresponding to 50% of the limit design load factor. Flight tests showed the practical possibilities of this design feature. The two wing tips and the aileron tips broke off simultaneously during a symmetrical pullout. The airplane was found to be perfectly maneuverable with its wings clipped and a safe landing was made under adverse conditions (20 m.p.h. cross wind). Flights were also made with only one wing tip off, and showed that the airplane in that configuration had satisfactory flying characteristics, and could make safe take-offs and landings."



Typical wing-section strength diagram. (From *Flight-Test Investigation of the Strength of a Square-Tipped Wing.*)

Extensive instrumented flight tests were conducted thereafter on a recent fighter model airplane featuring square-tipped wings with the purpose of establishing speed and load factor restrictions based on the actual strength of the wing. Loads were measured at three wing stations, the root, mid-span, and near the tip, in order to establish the relationship of strength between these three sections such that the tip section would remain critical under any symmetrical flight condition.

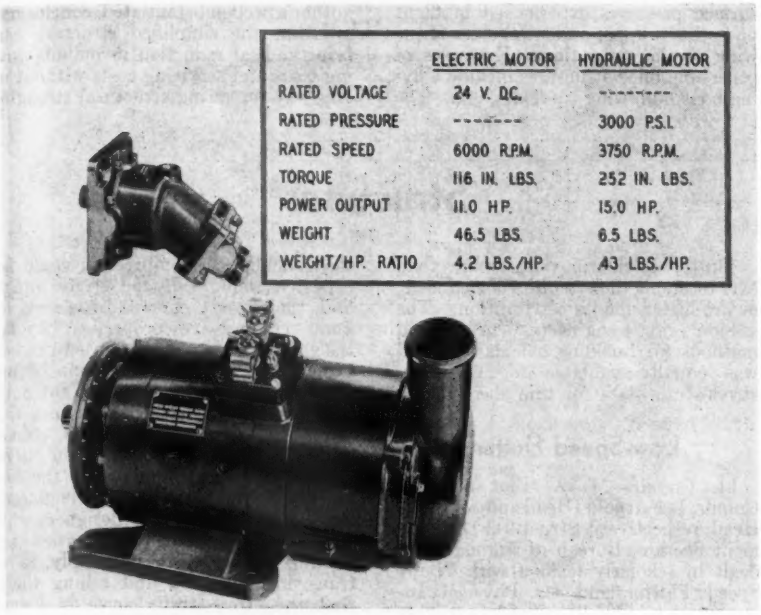
The test procedure and the method of interpretation of wing load test data are described in this paper. The results of the tests are discussed and deviations from calculated design loads are brought forward. The typical cases of a high g design airplane and of a low g design airplane having the same wing loading are considered. The merits of the square-tipped wings are analyzed with regard to the possibility of achieving localized failures.

Hydraulic Motors

In the introduction to "Hydraulic Motors and Their Application to Aircraft," James Robinson (Assistant Chief Engineer, Vickers, Inc.), states correctly that of the many accessories used in aircraft the hydraulic motor is probably the least known although more hydraulic motors are used than hydraulic pumps. Mr. Robinson has filled the gap in his paper which deals with motors that convert hydraulic power into rotary motion. The greatest use of this equipment is probably in aircraft turret drives. Their trouble-free operation is probably the explanation for the forgetfulness these motors have earned. The author believes that a strong case can be made for the hydraulic motor as compared with an electric one, and states: "Hydraulic tubing can transmit considerably more horsepower per pound, except in the fractional horsepower group. A typical comparison shows that with a weight of 0.25 pound per foot it is possible to transmit 5.40 h.p. electrically, while for less than that weight, in two tubes full of oil, it is possible to transmit almost 12 h.p. hydraulically."

The figure shown on this page seems to show a generous margin for the hydraulic motor in size and weight reduction.

"The hydraulic motor can be very rapidly accelerated or decelerated. It is also possible to obtain almost instantaneous reversals from full speed in one direction to full speed in the opposite direction, due to the light weight and low moment of inertia. A 24-volt 2 h.p. 4000 r.p.m. electric motor weighing 18.5 pounds has a moment of inertia of its revolving parts of approximately 5 pound inches^2, while a hydraulic motor rated at 2 h.p. 4000 r.p.m. at a rated pressure of only 1200 p.s.i., has a weight of less than $2^1/_2$ pounds and a moment



(From *Hydraulic Motors and Their Application to Aircraft.*)

of inertia of 0.44 pound inches^2." Again no thermal protection is required, no lubrication and a hydraulic motor can be stalled indefinitely at full rated torque without causing damage. Some typical installations described and illustrated include a typical hydraulic turret installation; a wing flap hydraulic mechanism on the C-74, and in the helicopter hydraulically operated hoist where "a helicopter took off, hovered over the first life raft, and hoisted a man up to the aircraft. He was easily swung into the cabin. The helicopter then returned, hovered over the vessel, and lowered the survivor to the deck. All four survivors were similarly rescued and the entire operation required less than ten minutes to complete." It is true that a manufacturer of electrical equipment might have some contrary arguments to advance, but Mr. Robinson's paper deserves careful study.

Simplified Structures for Low Cost Airplanes

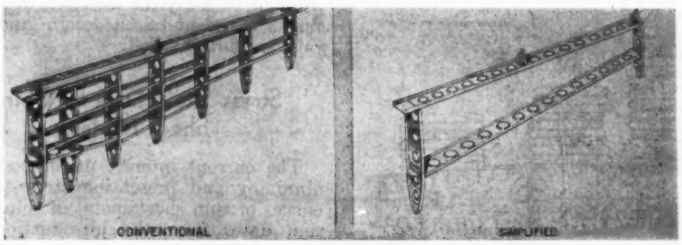
Alfred Z. Boyajian (Structures Project Engineer, Republic Aviation Corporation), in the "Design of Simplified Structures for Low-Cost Airplanes" related, in a highly original approach, the structural design of air frames to production problems and costs. In the last 10 or 12 years, there have been many improvements in the design of structural components, such as spar flanges that work at twice the normal stresses of 10 years ago, in shear webs, sheet-stringer combinations, in detail design of joints and fillings. But, according to the author, the basic arrangement of the air frame, wherein these improved components are used collectively, has received little attention. It is with this basic arrangement that the author, writing with the support of successful experiments, is concerned. These experiments began with the design and construction of small ribless wings or control surfaces, with the following theoretical considerations:

"According to all customary methods of stress analysis used in stressed skin wings, it is impossible to transfer normal shear loads in a chordwise direction to the spars without conventional shear carrying trusses such as ribs. However, it was felt that if the cover of a stressed skin wing were stiffened so that it became a heavily stiffened torque box, such transfer of shear loads may be possible with a minimum of internal structure. This type of wing would approach the case of a large streamlined tube with a low diameter-thickness ratio capable of supporting local loads."

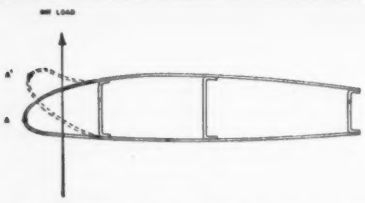
It was in the stabilizer of the Republic Seabee that the elimination of conventional internal ribs was first attempted. The entirely conventional structure composed of metal spars, ribs, stringers, etc., a type of structure with which we are familiar, was converted to a simplified version, with no ribs or stringers, two spars and external longitudinal beads on the skins, whose aerodynamic resistance is not considered objectionable in a low-speed airplane. The same principles of conversion were applied to the whole wing of the same airplane.

The author believes that the new structures work better than equivalent conventional design. The simplified wing was able to support 100 per cent of the design load without a ripple or a buckle on its surface, not even on the critical compressive side. Another experiment comparison of the bending and leading edge rigidity between a standard P-47 fin and the simplified version, showed that the deflection of the leading edge of the simplified fin was less than that of the standard fin. These experiments are striking and convincing; the author supports them by a discussion which deserves textual quotation:

"According to customary methods of stress analysis the foregoing simplified structures are lacking in strength. The omission of the conventional ribs leaves no apparent structure capable of transferring air load shears in a chordwise direction to the bending resistant spars. The author believes there is nothing wrong with the fundamental laws and theories of stress analysis, but rather that sometimes discrepancies arise in their application. In the analysis of shearloads in a chordwise direction and for stressed skin wings the theory customarily used is as follows: that a section of a wing, containing a rib, can be isolated and analyzed as an independent structure, because it is assumed that the rest of the wing supplies nothing important and can be safely neglected. This theory and assumption have been responsible for the presence of the conventional ribs in a conventional stressed skin wing, and the ribs in turn have been responsible for anywhere up to 70 or 80% of the total production time required during manufacture. If the old theory is applied to the above mentioned simplified wing, it is obvious that the section is highly deficient in shear strength. It is not capable of transferring but a small fraction of shear loads in a chordwise direction to the spars. Such a section of the wing is an incomplete structure until the section is extended spanwise to include the end ribs. Then it becomes possible for a number of factors to contribute the necessary shear strength, all of which are ordinarily unaccounted for and assumed to be of negligible worth. It is belived that the first and most prominent of these factors is the presence of the torque box. If an isolated section without end ribs were considered



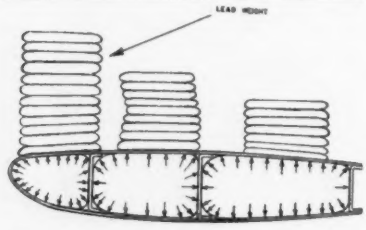
Internal framework of a conventional and simplified stabilizer. (From *Design of Simplified Structures for Low-Cost Airplanes.*)



Shear deflection of leading edge under air load. (From *Design of Simplified Structures for Low-Cost Airplanes.*)

point A in Fig. 0 would deflect under air load to some position A′ due to lack of shear rigidity. Such a deflection in the center of the span would represent large torsional displacement with respect to the end ribs. However, the powerful torque box, which makes up the leading edge of a stressed skin wing, offers considerable restraint to such torsional displacement. It is further believed that the leading edge cell (as well as the aft cells) will work somewhat as a beam in bending between the end ribs. The secondary spars, amongst other functions, also serve in this manner. In addition, it is believed that the individual beads on the leading edge skin of the simplified Seabee wing work partially as truss members pinned at the leading edge. The old theory of isolating a rib and stress-analyzing it as an independent structure is a throwback to the days of fabric-covered wings where its use was quite justified. However, its application to a stressed skin wing is not so reasonable."

Mr. Boyajian developed other stress considerations for the simplified wing. He also describes a novel static test method which simulates the surface loadings experienced in flight closely. It makes use of inflated air bags within the wing to react the live loads used during a test, and eliminates the danger of cruising the loaded surface of the wing due to the usual test setup. Airtight bags are placed inside the wing. The internal bags are inflated with air pressure equal in magnitude to the external negative pressure corresponding to the flight condition being tested. The internal air pressure in each bag is an average for its section of wing, and is held constant spanwise, but varies chordwise in accordance with the chordwise negative pressure distribution. In combination with the lead weights, the air pressure then gives in the test exactly the surface pressures experienced in flight on both the upper and lower sides of the wing at the same time. Examples of other simplified structures include a flying boat hull, wing tip floats, etc. The author's well-substantiated conclusions are that the simplified structure can bring radical reduction in manufacturing costs and servicing costs without in any way impairing structural strength.



Pressure reaction static test method. (From *Design of Simplified Structures for Low-Cost Airplanes.*)

Structures

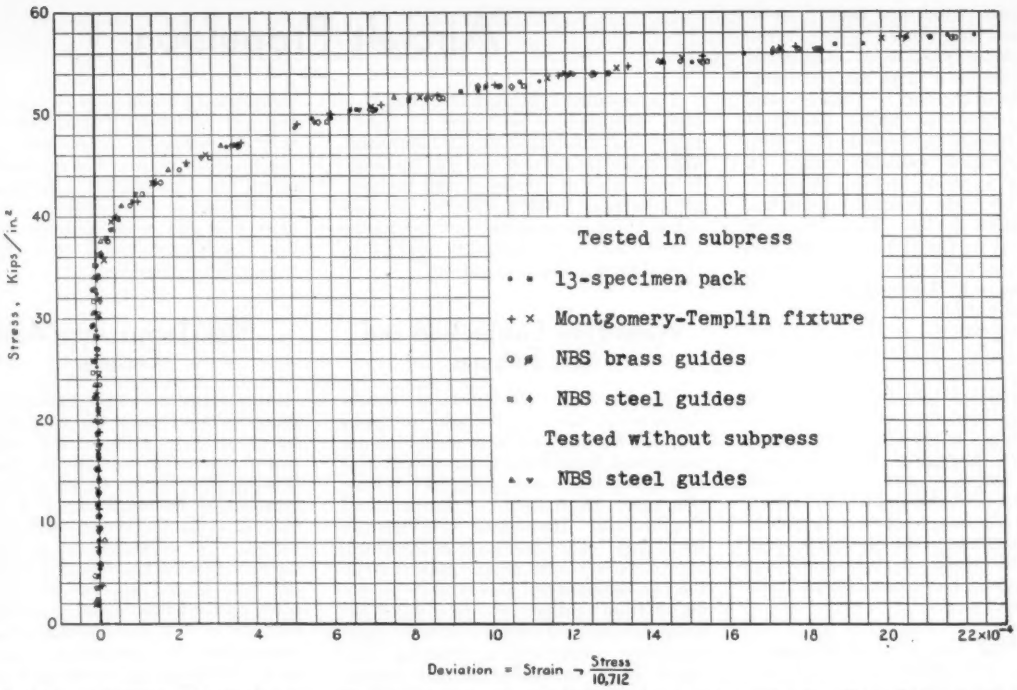
Flutter calculations are more than ever receiving the attention of engineers, as are higher modes of vibration. The session gave engineers' curves and methods for buckling calculations and was equally valuable for obtaining stress-strain data for thin sheet metal.

Low-Speed Flutter

Lt. Comdr. M. A. Biot and Lt. Comdr. Lee Arnold (Head and Assistant Head, respectively, Structural Development Section, Bureau of Aeronautics), dealt in scholarly fashion with "Low-Speed Flutter and Its Physical Interpretation" and have made available a fine summary of their paper. The phenomena of low-speed flutter of an oscillating airfoil are investigated. The problem resolves itself into the study of two phenomena: that of an airfoil oscillating with no vortex shed, and that of zero air-speed classic flutter. It is seen that both cases involve oscillation of the airfoil about a nodal line located three-quarters of the chord aft of the leading edge. The study is based on the fundamental theory developed by Theodorsen. For the first case, the solution of the equations of motion of the oscillating airfoil, based on non-circulatory flow, and the equation resulting from the Kutta condition, results in a relationship between the inertia and elastic parameters for which the airfoil will flutter (i.e., maintain oscillations at constant amplitude) for all air speeds. The physical interpretation and the mechanism of these phenomena are discussed. The relationship between the parameters required for zero-speed flutter for the more general case is developed and the physical interpretation of these phenomena is also discussed. Practical implications, such as the importance of nodal line location and the effect of the physical parameters of the airfoil on the nodal line location, are discussed. The possibility of a new approach to the flutter problem is suggested—that of employing the ground vibration modes of the airplane to study the existence of a low flutter speed and as a design guide to raise the flutter speed.

Stress-Strain Data for Thin Sheet Metal

The current interest in methods of obtaining and presenting stress-strain curves of thin sheet metal in compression dates from the introduction of stressed-skin structures in aircraft 10 or 15 years ago. The first stressed-skin structures were relatively inefficient in that buckling in compression could be expected well inside the elastic range and, therefore, there was little need to know compressive properties beyond the elastic range. As the structures became more efficient it became of increasing importance to know not only Young's modulus, which describes the stress-strain curve inside the elastic range, but also the stress-strain curve beyond the elastic range. In the beginning the materials-testing engineers were able to pacify the designers who were asking for this information by making tensile tests preferably in a transverse direction and telling them that the stress-strain curve in longitudinal compression would be approximated by the tensile stress-strain curve in a transverse direction. This was good enough for some commonly used aluminum alloys, but it soon proved entirely inadequate for other alloys, particularly stainless steels and magnesium alloys. In the case of these alloys no simple and reliable method has been found for determining longitudinal compressive properties from any tensile properties. In the end the materials engineers had to give in and make compressive tests of these alloys to determine their compressive properties. Several methods of testing have been developed and used. All of them have their limitations and none of them is in sufficiently general use to have earned for itself inclusion in the A.S.T.M. Standards. Faced with this situation, it seemed advisable to Walter Ramberg and James A. Miller (Physicist and Materials Engineer, respectively, National Bureau of Standards) to undertake a brief survey of the various known methods for the benefit of structural test engineers who are faced with the problem of making compressive tests without having had the time to look into the various methods. The authors describe in their paper "Determination and Presentation of Compressive Stress-Strain Data for Thin Sheet Metal" various methods of obtaining the compressive stress-strain curve of thin sheet metal, and their advantages and limitations. The presentation of stress-strain data in dimensionless form is outlined and the advantages of such a presentation in correcting for the effect of variations in yield strength and in Young's modulus are brought out. Attention is called to a classification of stress-strain curves by shape factors following a 3-parameter formula proposed by Osgood. Stress analysts will find a bibliography at the end of the paper, and the authors' conclusions are an excellent guide to the use of the paper itself as well as to the literature of the subject. Accurate



Compressive data on 0.032-in. 24S-RT aluminum-alloy sheet in direction of rolling, tested by five methods. (From *Determination and Presentation of Compressive Stress-Strain Data for Thin Sheet Metal.*)

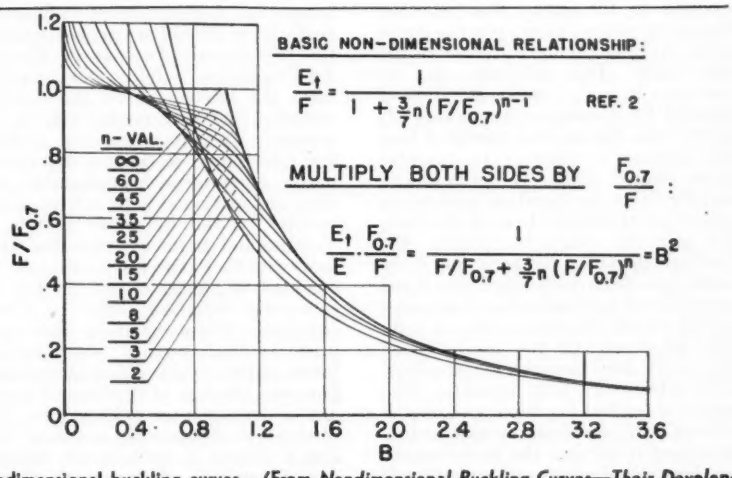
values of the compressive stress-strain curve up to stresses of 60,000 lbs. per sq. in. may be obtained on sheet with a thickness not less than 0.02 in. by any one of the following methods: pack method, Montgomery-Templin method, N.B.S.' solid-guid method, N.A.C.A. solid-guide method, and A.R.M.C.O. solid-guide method. The stress-strain curves for much stronger materials and for thinner gages may be obtained by several of these methods if proper attention is given to the preparation of the specimen and to details of the testing procedure. The effects of small variations in Young's modulus and in yield strength on the stress-strain curve and on the buckling stress in the plastic range can be estimated frequently from dimensionless curves of stress vs. strain and of tangent modulus and reduced modulus vs. stress. A large class of stress-strain curves, which however, does not include Alclad aluminum alloys, can be described by a simple formula proposed by Osgood which requires a knowledge of only one parameter in addition to Young's modulus and a secant yield strength. A convenient set of three such parameters is Young's modulus, and the secant yield strengths corresponding to slopes of $0.7E$ and $0.85E$.

Buckling Curves

"Nondimensional Buckling Curves—Their Development and Application," by F. P. Cozzone and M. A. Melcon (Structural Methods Department Engineer and Structures Engineer, respectively, Lockheed Aircraft Corporation), will be welcomed because it will provide, for stress analysts dealing with the complexities of buckling, a selection of formulas and curves covering almost every conceivable condition, and sure guidance for their application. Basic expressions for column buckling, initial buckling in compression, initial buckling in shear, interrivet buckling, and local crippling are reduced to a common parameter: namely, the ratio of tangent modulus to buckling stress. A nondimentional buckling parameter is plotted and the shape parameter is determined by the shape of the knee of the stress-strain curve. Constants for evaluating the buckling parameters for the various types of buckling phenomena, values of the secant yield stress, and the shape parameter are tabulated for the materials commonly used in aircraft. It is shown that these nondimensional buekling curves when entered with the proper buckling parameter may be used to evaluate the buckling values required for design.

Determination of Higher Modes of Vibration

L. Beskin (Design Specialist, Consolidated Vultee Aircraft Corporation) and R. M. Rosenberg (Consulting Engineer), writing on "Determination of Higher Modes of Vibration by a Method of Sweeping," approached a



Nondimensional buckling curves. (From *Nondimensional Buckling Curves—Their Development and Applications.*)

field in which much has been done in recent years, introduced a new term, and placed the process of calculating higher modes on a more assured basis. When computing the frequencies and deflection curves of higher modes of vibration in systems of constant section, straight forward solutions exist. In systems of variable section, laborious iteration methods permit approximations to higher modes. These iteration methods rely on the Holzer method and its variations make use of the fact that, in the absence of damping, the force in bending vibrations (or the torque in torsional vibrations) required to excite principal modes of vibrations, is zero. All other methods make use of the orthogonality relation between normal modes. Without disclosing new physical principles, the present paper applies a method of "sweeping" to an assumed deflection curve to clear from it the lower modes. Stodola's method is then applied to the swept curve and results in the convergence of the Stodola process to the nth mode if the preceding $(n - 1)$ modes have been swept from the function.

In applying the method discussed here to the nth mode a "reasonable" estimate of the deflection curve of the nth mode is made, which not only satisfies the boundary conditions but also possesses the known general character of the mode. Thus, a reasonable deflection curve of the nth mode of a cantilever beam in bending vibrations possesses $(n - 1)$ modes and has zero deflection and slope at the root. The components of the preceding $(n - 1)$ modes (as determined by previous computations) are cleaned or "swept" from the assumed curve whereupon it is subjected to the Stodola Process. All modes up to the $(n - 1)$st are themselves, determined by a converging iteration process. They can, therefore, be swept from the assumed curve only within the accuracy with which they have been determined. It must be assumed, then, that residuals of the lower modes are left even after sweeping and continued application of the Stodola process will amplify these residuals to the extent that repeated Stodola iterations, done upon the swept curve, will eventually converge to the first mode. This difficulty can be overcome if each Stodola iteration is followed by a sweeping procedure. If this is done, the method presented here will continue indefinitely to converge to the desired mode. It can be shown that the sweeping operation need not be applied in its entirety to each iteration. For instance, when calculating the fourth mode and if the preceding three modes have been determined with equal accuracy, the first mode should be swept out after each iteration; but it is sufficient to sweep out the second mode after every other iteration and the third mode after every fifth iteration. The method described has been used by the authors with excellent results and is considered to present the best compromise between accuracy and reduction of labor known to them.

Aircraft Propulsion

The session confirmed the view that high temperature advances in metallurgy and insulation are indispensable aids to jet propulsion and gas turbines. If axial flow compressors and turbines are now much better understood it is because three-dimensional hydrodynamic theory has been skillfully applied to their design and investigation.

Axial-Flow Compressors and Gas Turbines

Capacity and efficiency of turbomachines should be advanced by application of the analysis of "Fluid-Dynamic Aspects of Axial-Flow Compressors and Gas Turbines," by John R. Weske (Professor, Department of Aeronautical Engineering, Rensselaer Polytechnic Institute). The significant gains which have been achieved from application of the two-dimensional theory may be expected from a proper consideration of the three-dimensionalaspects of flowthrough axial-flow blade rows. Certain elements of a three-dimensional theory were developed in close coordination with the two-dimensional theory, whose assumptions, results and limitations were critically surveyed. Basic relations of potential flow and vortex theory were seen to acquire new practical significance when applied to the flow through blade rows. The effect of various factors responsible for three-dimensional flow, such as relative rotation, thickness effects, compressibility effect, boundary layer displacement and secondary flows, is considered in its qualitative aspects, and, where susceptible of numerical treatment, defined quantitatively. Results are of interest as they relate to features of design and to characteristics of operation of turbomachines.

Thermal Jet Propulsion

Hans Reissner (Professor, Aerodynamics and Aerostructures, Polytechnic Institute of Brooklyn) gave a paper on the "Systematic Analysis of Thermal Jet Propulsion." Jet propulsion passes from the miraculous to the severely technical and such papers help in the process. The propulsion unit is divisible into the six sections of free inflow, intake, compressor, heat chamber, turbine, and exit nozzle. It is treated uniformly by the quintuple system of dynamic and thermodynamic flow equations with their power or heat input, the condition of change-of-rate (cycle), the continuity equation, and the thrust equation. These equations also comprise, in each section, the retarding forces and the heat creation of turbulent flow and the loss of mechanical power and of heat leakage. They form successive sets of equations, and their solution is derived in terms of the required data of altitude, flying speed, thrust, pressures in front and at the exit of the compressor, permissible entrance temperature at the turbine and permissible ratio of power of compressor and turbine to heat input. The necessary heat input, the propulsion efficiency, the distribution of temperatures, pressures, velocities and cross sections, and the best cycle conditions are then determined by those data.

High-Temperature Alloy Castings

Another paper in the modern powerplant field in which the effects of high temperature constituted the main subject of discussion was one on "Application of High-Temperature Alloy Castings to Gas Turbines," by F. S. Badger (Vice-President, Haynes Stellite Company). The design and method of manufacture of the reaction blading in the case of the gas turbine engineer, takes precedence over anything else because of the high temperatures involved and the limitations of available metals for these highly stressed rotating members. The solution of the blading problem in the mass produced Type "B" turbosupercharger by the use of precision-cast Haynes Stellite-type blades or so-called buckets for maximum operating temperatures between 1,500°F. and 1,600°F. gave renewed hope to gas turbine designers, who were generally designing for temperatures of only 1,000°F., or at the highest 1,200°F. The use of castings for these precisely made high-temperature parts from relatively unmachinable alloys was not achieved without considerable experience. Diversity of opinion still exists as to advantages of forgings and castings for these parts. It was the chief purpose of the paper to point out the production and metallurgical problems which have been met and the methods followed in solving them, and also to facilitate selection between forgings and castings. The author reviews the developments of recent years, and considers metallurgy composition and strength of a number of alloys, as well as manufacturing processes. Haynes Stellite cast buckets for superchargers have proved highly satisfactory. In jet propulsion blading where operating temperatures are lower than in the supercharger, the advantage lay at first with forgings because the operating temperature of 1,200 to 1,350°F. was below the equicohesive temperature. Buckets cast of a new type of alloy, I-40, employed because forging facilities could not be created quickly enough, were given a shorter life rating. But now there appears to be no difference in life. In regard to grain sizes in castings the author states that extremely coarse grain size results in wide variations in the modulus of elasticity, not only from casting to casting, but also on the same casting when tested in different directions. Another phenomenon which has created controversy among metallurgists

using precision cast blading is the so-called coring pattern effect—showing up on X-ray negatives of Haynes Stellite-type precision castings. The discussion of grain sizes leads to the question—why not make fine-grained castings inasmuch as coarse-grain size appears a somewhat mixed blessing. But fine-grained centrifugal types of casting are not favorable to a high yield where the high standards of acceptance as to surface blemishes and internal defects are in force and the benefits of mass production and resulting economy of costs are not attained. Other methods of obtaining fine grain are not practical with the thin sections down to 0.030 in. and 0.020 in. required by turbine engineers but many of the worst features of large and variable grain size can be readily eliminated, if the design engineers will so construct their blades that abrupt changes in section are minimized. In speaking of less critical parts, Mr. Badger points out that the precision-casting process has been of equal importance in jet engines in the production of stationary vanes and of low-temperature rotating compressor blades.

The paper concludes with a discussion of hollow and intricate castings. The lightness of German jet-engine designs has appeared attractive to turbine engineers, and increased impetus has been given to hollow blading constructed from sheet or other wrought material. However, hollow-cast blades have been receiving a great deal of attention for several years in experimental designs, and their value in wall thickness down to 0.030 in. has been demonstrated. Hollow-cast stationary vanes are also receiving much attention, and here also the production possibilities of castings are attractive as compared with fabrication. Many intricate solid and hollow parts which could not be readily produced otherwise are being produced by the precision-casting method for advanced gas turbine designs. However, close cooperation between design engineers and foundry engineers is necessary so that problems involving minor design changes and coring details can be worked out and the production of suitable wax injection dies assured.

High-Temperature Lightweight Insulation

Donald Jelinek (Mechanical Research Engineer, North American Aviation, Inc.) in a paper on "The Development of a High-Temperature Lightweight Insulation for Jet-Propelled Aircraft" begins by saying that an efficient high-temperature insulation for jet-propelled aircraft is needed because high temperature reduces the strength of aluminum alloys. Maximum air-frame temperature of 200°F. is a reasonable limit for design to avoid excessive decrease in structural strength. The air-frame temperature must be maintained below this maximum by dissipation or insulation of the surface heat of the engine assembly. Dissipation of the amount of heat thus involved would require a high rate of airflow around the heat source, a consequent increase in the airplane drag, and a decrease in thermal efficiency of the jet engine, which are all undesirable. Insulation of the heat source to produce the necessary temperature differential would require excessive weight if commercially available materials were used. Heat dissipation and appropriate insulation appears to be the most satisfactory solution to the problem. An investigation was first conducted to determine the thermal properties of all materials promising the following characteristics: (A) maximum thermal resistance per pound; (B) effective at temperatures encountered on the surfaces of jet engines and tail pipes; (C) adaptable to design; (D) durable; (E) easy to maintain.

After the preliminary investigation, a thermal conductivity tester was designed and built to aid in selection on the basis of thermal conductivity and transmittance values at high mean temperatures. Three types of insulation were considered: blanket and loose-fill materials, radiation shielding, and combinations of the two. A leached Fiberglas-reflective foil combination insulation was found to be the best of the three types, possessing the highest thermal resistance per pound and being readily adapted to jet aircraft applications requiring the lowest cooling airflow around the insulation. The designer of jet aircraft will be particularly thankful for the series of charts where thermal resistance permit weight of insulating materials is plotted against mean temperature.

INSULATION	SPECIFIC WEIGHT (LB/FT³)	THERMAL CONDUCTIVITY COEFFICIENTS (AT 700°F ARITHMETIC MEAN TEMP.) BTU/(HR)(FT²)(F°/FT)	BTU/(HR)(FT²)(F°/IN)
FIBERGLAS WOOL	1/2–3	—	—
PERLITE (8 MESH)	5–6	—	—
OPACIFIED SANTOCEL	8	—	—
EXPLODED MICA (4 MESH OR SMALLER)	8–10	—	—
AMOSITE FIBERS	10	—	—
DICOLITE POWDER	10–15	.046	.55
DUROCEL FILL	13–18	—	—
FIBRO CEL	18	—	—
HIGH TEMP. NO. 19	19	.071	.85
SUPEREX	24	.06	.72
VITRIFIED ASBESTOS FIBRE BLOCK	30	.0685	.821
HIGH GRADE ASBESTOS MILLBOARD	50-60	1.7	20.4
PHLOGRAPHITE (AMBER) MICA	140–160	.25	3.00
RADIATION SHIELDING	—	—	—

Table of high- temperature insulations (published information). (From *The Development of a High-Temperature, Lightweight Insulation for Jet-Propelled Aircraft.*)

Engine Cooling

With the increasing and concentrated power of our engines direct air cooling becomes difficult, and engine driven blowers a necessity. Another solution lies in the "Design of an Exhaust Pump for Engine Cooling," defined by Carl de Ganahl (Director of Research, Fleetwings Division, Kaiser Cargo, Inc.) as accomplishing the required cooling of an aircraft engine by using the velocity energy in the exhaust for sucking the cooling air through the engine. The pump consists of a closed cowl in which the engine is sealed except for the usual inlet at the front, and one or more relatively small mixing ducts or augmenters extending from the rear of the engine compartment to a point fairly well aft of the maximum ordinate of the wing. These ducts open to the atmosphere, perferably with a divergent section of variable divergence at the outlet. Two mixing ducts, one on either side of the fuselage, appear to be the most satisfactory installation for a single-engined low-wing design. Usually it is found the mixing duct is more efficient and easier to build if it is of constant cross-sectional area with a properly streamlined entrance into which the ends of the exhaust stacks project, stopping just short of the throat of the mixing duct. The steadier the flow the greater is the capacity of a given mixing duct area, and it is, therefore, desirable to Siamese two exhaust stacks without overlap so that the flow will be as continuous as possible. From the periods at which the exhaust valves are open over two revolutions of the engine it can be determined what combinations of exhaust ports can be Siamesed into a single exhaust port without overlap of the exhaust flow. The area behind the cylinders should be sealed off from the rear case holding the engine auxiliaries, and the flow of cooling air to the mixing ducts should encounter a minimum of interference. The velocity energy in the exhaust gases sucks the cooling air into the mixing duct where its momentum is mixed with that of the cooling air, and is ejected to atmosphere rearwardly according to the momentum equation. Under certain conditions it is ejected with greater momentum than is contained in the exhaust gases alone, thus producing an appreciable improvement in thrust.

A number of advantages are justifiably claimed for the system:

(1) It cools under all conditions of flight.

(2) Better ground cooling.

(3) Eliminates cooling drag and delivers some thrust power.
(4) Improves the high speed somewhat and rate of climb materially.
(5) It is a complete flame damper.
(6) Improves the streamlined characteristics of the airplane.
(7) Acts as an excellent silencer anywhere forward of a 45° cone with the exit of the pump as the apex of the cone.

The design of the pump involves many mechanical and structural problems which have been solved, such as proper shock mounting, sufficient local stiffness, and the elimination of stress concentrations created by impact from the exhaust nozzles. The correct mathematical theory in designing a suitable variable divergence at the end of the mixing duct, in determining duct area in writing momentum equations, combining aerodynamics and thermodynamics calculating thrust, etc., is carefully and clearly presented in a sample calculation. Thrust augmentation, as well as cooling, is computed in a representative example. The author also discusses the problems presented by high speeds and cold weather when overcooling must be prevented and maximum thrust is reduced. The application of such a pump should appeal to designers of power-plant installations and to airplane designers themselves.

Rotating Wing Aircraft

The session brought forth four serious papers, in itself an indication of the growing importance of the rotating-wing type of aircraft. The problem of stress analysis of rotating blades was carried a step further, both in the flapping plane and in the plane of rotation. Another paper brought a better understanding of ground vibration. An investigation of airflow beneath the helicopter rotors showed that there is much to be done in reconciling theory and experiment.

Blade Analysis

Daniel O. Dommasch (Aeronautical Engineer, C.A.A.) took up "The General Equations for the Analysis of Rotor or Propeller Blades." The present paper is an extension of an earlier work which dealt with the analysis of rotor blades of constant section. The author defined his method of procedure in the earlier paper as follows: "It may be stated that at this time no 'exact' solution has been found for even the simplest form of the differential equation involved, although solutions can be determined for certain combinations of constants (these solutions are not general). Because of the lack of a general exact solution various approximate methods such as series, perturbation methods, etc., were tried; however, convergence was poor in all cases, necessitating the use of an unwieldy number of terms. The solution presented in this paper is based on the method of finite differences and depends on the evaluation of a number of simultaneous linear equations." The method leads to a rapid determination of the bending moment of any point on the blade. The equations presented provide for the determination of the shear, axial load, and bending moment in a rotor (or propeller) blade of any plan form and subjected to any loading. There are no restrictions on continuity of the equations for moment of inertia or area of the blade except that the blade is assumed elastically continuous throughout its span. If hinged rotors are considered it can be demonstrated that the moment is almost negligible over the entire blade (in comparison with moment developed in rigid blades) provided that flapping inertia loads and hinge damping do not exist (provided, of course, that the blade is not subject to periodic forces causing vibration at its natural frequency). If appreciable hinge damping alone exists, it can be shown that the moment is a maximum at the blade root (consideration of hinge damping requires modification of the boundary conditions at the hinged end of the blade). If it is desired to consider flapping inertia and gyroscopic loads on hinged rotors, these loads may be introduced *as external loads* in the general equations without modification of the equations. However, determination of such loads is a separate problem not considered here.

Rotor Blade Bending

While a good deal has been written on the motion of the blade in the plane of flapping, little appears in the literature regarding forces or bending in the plane of rotation. Therefore, the paper by Shao Wen Yuan (Research Adviser, Polytechnic Institute of Brooklyn), on "Bending of Rotor Blade in the Plane of Rotation" is welcome. In his excellent introduction the author summarizes both the method of approach and the results attained. The bending of the rotor blade in the plane of rotation is of particular importance in the design of the present steel spar and fabric-covered blade as the bending rigidity in the plane of rotation is about equal to that in the flapping plane. The deflection of the rotor blade in the plane of rotation gives, as observed in flight tests, a certain amount of pitching moment which has an adverse effect upon control. It is expected that this pitching moment can be reduced to a minimum by initially bending the blade forward if the amount of deflection in the plane of rotation is known. In the solution of the problem of the bending of the rotor blade in the plane of rotation the differential equation of motion of the blade is derived from a consideration of the forces which act on a blade element of length dr. They are the so-called aerodynamic torque, the component of the centrifugal force perpendicular to dr, the inertia force and the Coriolis force. Since the weight of the blade is seldom distributed uniformly over the span, a method of calculating the bending of the blade with variable mass distribution is developed. If the mass distribution and the bending rigidity distribution are known for a given rotor blade of variable mass distribution the bending moments and the deflections can be calculated in a manner similar to that used in the case of the uniformly distributed mass. The differential equations are then solved by the method of collocation. The same degree of accuracy is obtained as in the case of constant mass distribution along the blade span.

In this paper the analysis is carried out for the nontwisted blade with constant chord. However, for a twisted blade with tapered chord only the blade loading expression need be modified. The expressions presented were developed on the basis of the first three terms of the Fourier series expansions because the consideration of more terms would lead to entirely unwieldy equations. On the other hand the numerical example was worked out using five terms of the Fourier series. The maximum bending moment found when five terms were considered was about 20 per cent higher than that obtained when three terms were used. The results found in the case of a typical rotor blade show that the maximum deflection in the plane of rotation is about one-tenth of that in the flapping plane, and the maximum bending moment in the plane of rotation about one-fourth of that in the flapping plane.

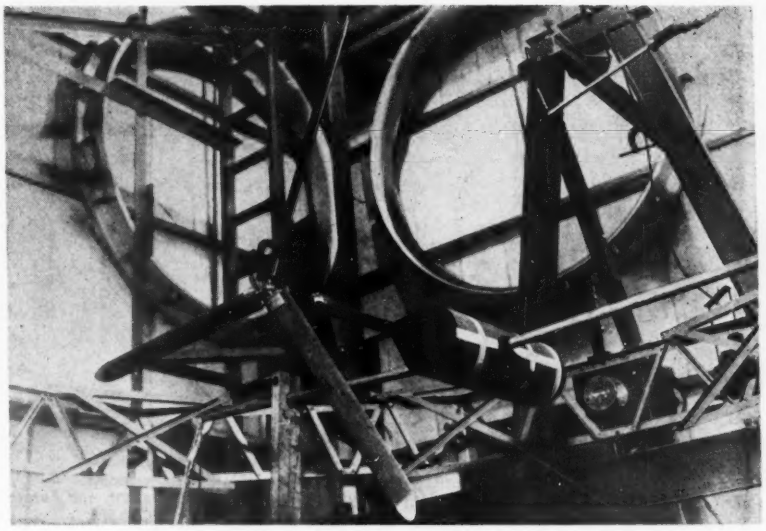
When a blade with variable section is compared to one with an equivalent constant blade section, in the region of the inner half span the bending moment for the variable section is found to be appreciably greater than that for the equivalent constant section. The reason for this phenomenon is that the variable blade section has a greater bending rigidity in the inner portion of the blade span. It is somewhat unconservative to assume an equivalent constant section, as done in present practice, as the maximum bending moment of the rotor blade in the plane of rotation generally occurs at about 20 per cent of the span.

Airflow Underneath Helicopter Rotors

"An Investigation of the Airflow Underneath Helicopter Rotors," by Robert S. Ross (Research Engineer, Daniel Guggenheim Airship Institute) is of considerable interest because so little information is available on such flow. The experimental results obtained deserve careful study. The author places perhaps too much reliance on elementary theory and is surprised that experimental and theoretical values do not agree. The author's Abstract is

as follows: The airflow underneath helicopter rotors, as determined by the classical blade element and momentum theories without the assumptions of constant chord or constant circulation along the span, was estimated from the theoretically determined charts. These values were compared with those obtained from the actual measurements taken near a model rotor with a "hot-wire" anemometer.

Both time-average and instantaneous readings of velocity were taken at simulated hovering and horizontal flight conditions. These measurements showed the theoretical estimation to be good at low angles of attack and at positions not too near the blade tips. They also indicated the pulsations that occur in horizontal flight and showed these to be of unanticipated magnitude. Positions of maximum and minimum effect were tested to get the range of pulsation. This method of determining rotor characteristics was different from those now employed and the equipment used was built specially for these tests. The instruments were easy to handle and offered an improved picture of the distribution of rotor forces.



Bottom view of rotors set for horizontal flight tests. (From *An Investigation of the Airflow Underneath Helicopter Rotors.*)

Vibrations of a Helicopter on the Ground

Gabriel Horvay (Research Engineer, Helicopter Research Division, McDonnell Aircraft Corporation) has made a scholarly and original study of "Vibrations of a Helicopter on the Ground." His paper includes the following summary:

"Instability of a helicopter on the ground, due to the interaction between the rotor blades oscillating about the lag hinges and the helicopter rocking on the tires, is known as ground vibration. In earlier construction of rotorcraft there were no lag hinges and no ground vibrations. However, rotor blades were subjected to unusually large chordwise bending moments and breakages occurred. To eliminate the large bending moments at the blade roots, lag hinges came into use. These provided considerable relief from the bending moments but ground instability also entered the picture. Many rotorcraft were destroyed on the ground because of the new kind of instability. The trouble was remedied by the introduction of lag motion dampers attached to the blades. The dampers eliminated ground vibrations but they created fairly large bending moments at the blade roots, and the structural strength of blades has again become a matter of serious concern. It is, therefore, important to know what is the least amount of blade damping which is adequate to prevent instability. Of course, this determination can be carried out experimentally and with safety for any given helicopter, as described by M. L. Deutsch in his recent paper. The determination of the general effect of the various parameters of the helicopter on ground vibration characteristics, such as height of helicopter c.g., height of rotor, width of wheel base, eccentricity of lag hinge, coupling between lateral motion and rolling, etc., is a study which requires a theoretical approach."

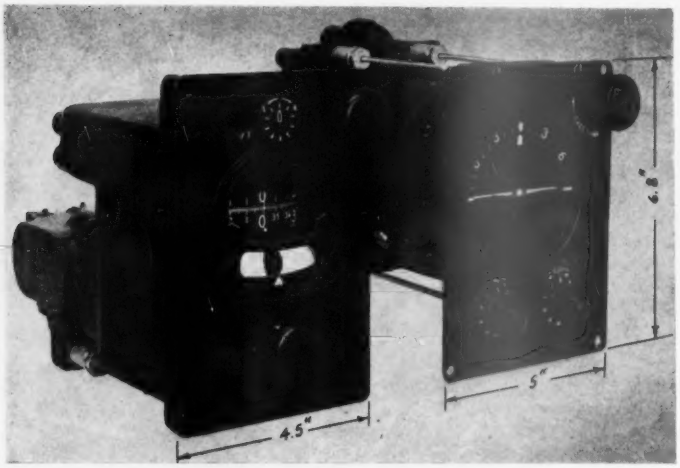
The present paper serves as an introduction to ground-vibration analysis. Considerable insight can be gained into the phenomenon of ground vibrations, without actually going into the analysis of these somewhat complicated self-excited oscillations, by limiting one's attention to the much simpler problem, that of forced vibrations of the helicopter on the ground, with the blade hinges locked. This preliminary study permits one to determine the natural modes of the helicopter, the ratios of the various amplitudes at resonance, and the magnitudes of the oscillations and of the blade unbalance forces at which shock-strut action sets in. The connection between the present study and ground vibration analysis is taken up briefly, and a numerical example is given. The spring and damping constants of a tire-shock strut combination are determined, and a discussion is given of the various constants of the shock absorber which play a role in ground vibrations.

Instruments

An account of vibration equipment proved that such equipment is no longer formidable in comprehension and use, and is commercially available. Resistance wire strain gages are now serving well in many secondary applications and are continuing to serve in many propeller investigations. As secrecy lifts regarding automatic pilots, many new applications are revealed and their future in military and commercial applications becomes a good deal clearer.

Automatic Pilots

Lt. R. L. Johnson (Instrument Branch, Bureau of Aeronautics, Navy Department), writing on "Automatic Pilots—Past, Present, and Future," gives the performance characteristics of past and current automatic pilots and looks into the future. A statement of the general requirement for any autopilot is easily made. It must provide control of the aircraft adequate for the purpose installed and it must do this with minimum weight and maximum reliability. The first conception of the purpose of an autopilot was that of pilot relief. By relieving the pilot of the tedium of routine flying, thus cutting down pilot fatigue, the pilot was not only made more comfortable but he was better able to apply himself to navigation, search, etc. Most important of these past autopilots were the Sperry S-4, S-3, and S-4 designs. These were all of the pneumatic-hydraulic type, i.e., the "intelligence system," consisting of the gyros and the signal pickoffs, was air operated, while the "muscle system," consisting of servopistons permanently connected into the control cables, was hydraulically operated at a pressure of about 100 lbs. per sq.in. After his review of former automatic pilots, Lieutenant Johnson gives a careful survey of present equipment, listing automatic pilots one by one. The Navy Type G-1 autopilot made by General Electric is still essentially a relief autopilot. It uses many of the hydraulic components of the Sperry S-4 autopilot. The primary difference is the change from an air-driven intelligence system to an electric-electronic system. It was designed for the heavier carrier aircraft which the S-4 autopilot would not handle. However, its design is such



Type S-3 autopilot gyro-control units. (From *Automatic Pilots—Past, Present, and Future.*)

that it will handle large aircraft as satisfactorily as the S-3 and is thus a step forward, eliminating the necessity of one autopilot for large aircraft and a smaller one for small aircraft. The change to an electric intelligence system is also a step forward. Longer gyro life results because of the fact that dirt and moisture-laden air are not being drawn through the instrument where the dirt can collect and the moisture condense. Electronic signal circuits in the intelligence system make the G-1 autopilot quite flexible, and a satisfactory interconnection with the bombsight has been developed although the autopilot was not originally designed with this in mind. In speaking of the Navy P-1 the possibility is emphasized of coordinated turns by means of a single controller turn knob; of dives and climbs by another knob, etc. During the war quite another objective was achieved by the automatic, accurate aircraft control for bombing. It was filled first by the Norden S.B.A.E. (Stabilized Bombing Approach Equipment), an all d.c. electric system. Gyros, servos, and signal circuits were all operated from the d.c. system. This system was modified by the A.A.F. and Minneapolis-Honeywell to make the signal circuits a.c. and given the designation Army Type C-1. The advantages of a.c. over d.c. signals are that they are smoother, provide more sensitive control and a more flexible intelligence system through the use of electronics. Since precision-control aircraft was essential, weight and size reduction did not bulk too large in design considerations and the result is a quite heavy autopilot (154 lbs.). However, the bombing results obtained have more than justified the weight. Toward the end of World War II new uses for autopilots arose, as for example use in night fighter operations. This use Lieutenant Johnson defines as follows: "An autopilot was required which would hold the aircraft in a set attitude or rate of turn and still permit easy maneuvering when required, thus allowing the pilots to devote full attention to the immediate problems-radio procedure and visual and radar-scope search for the enemy target. For fighter installation light weight and small size are essential. For night work, dependability and safety features are required. A most obvious safety feature is a control which when operated will return the aircraft, whether initially under control of the autopilot or not, to approximately level flight. Pilots suspecting vertigo or unable to recover by reference to their instruments could simply operate the button or lever and be returned to level flight automatically."

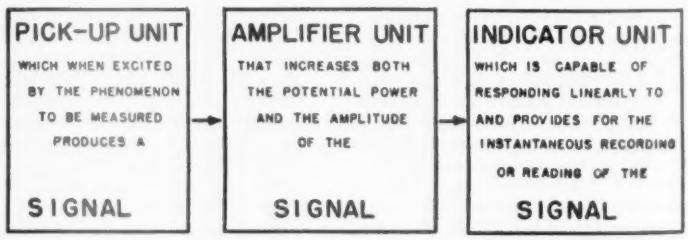
In the new automatic pilots coming to fruition or planned for the next 5 years here are the general requirements: (a) light weight; (b) dependable; (c) operative under any conceivable flight condition; (d) operable in rapid maneuvers through a simple finger-tip control; (e) easily interconnected with other equipment; (f) capable of supplying an azimuth or horizontal reference; (g) all electric-electronic; (h) magnetically controlled in direction with the option of reverting to gyro control at high latitudes if desired; (i) equipped to provide remote indication of direction; pitch, and bank; (j) capable of controlling aircraft of any size by changing only components of the "muscle" system; (k) easily maintained.

There is a final discussion of application of the future autopilot to commercial and private aircraft. After stating that an autopilot conforming to the 5-year goal specifications would have almost universal application in Navy and Army aircraft, the author writes that these same considerations, with the exception of the purely military interconnections such as bombsights, etc., apply equally as well to commercial aircraft. Use of this autopilot in private aircraft presents a somewhat different picture. In light, pleasure aircraft flown for convenience or for the enjoyment of flying the need for an autopilot is not evident. Flights are normally of short duration and in good weather, so that fatigue does not enter the picture. The various radar and radio interconnections are not required. In general it is believed that these considerations balanced against the cost in pounds and dollars will not allow the installation of these autopilots in private aircraft. There are many authorities who will disagree and argue that a cheap and simple automatic pilot for private flying is highly desirable.

Vibration Equipment

Harold V. Hawkins (Vibration Engineer, Bell Aircraft Corporation), in his paper on "Trouble Shooting with Vibration Equipment," dispelled the illusion that vibration equipment needed for aircraft investigations need be complex and too expensive. On the contrary, vibration equipment has now become "standard engineering equipment." The three types of instrumentation, including recording direct, with amplifiers, and with amplifiers and radio link, are then discussed briefly to show their relative merits. Recent developments in recording devices are shown to make the direct recording system adequate for most requirements. Pickup design is discussed in detail as being the only item requiring special adaptation to a specific test. Finally, an example of the application of vibration equipment is given in which torsional resonance was found as the cause for early failure of test specimens in a specially designed universal-joint testing machine. While, viewed as a whole, vibration equipment appears formidable, it may be broken down into three fundamental units.

The equipment measures the primary symptoms of vibration: (1) displacement, (2) velocity, and (3) acceleration, and, in addition, records can be made of (4) stress variation, (5) total loads on structural parts, (6) position of control mechanisms, (7) time sequences in relay circuits or mechanisms, (8) appearance of aerodynamic flutter or buffeting, (9) temperature vairation, (10) rate of turn,


PICK-UP UNIT
WHICH WHEN EXCITED BY THE PHENOMENON TO BE MEASURED PRODUCES A
SIGNAL
AMPLIFIER UNIT
THAT INCREASES BOTH THE POTENTIAL POWER AND THE AMPLITUDE OF THE
SIGNAL
INDICATOR UNIT
WHICH IS CAPABLE OF RESPONDING LINEARLY TO AND PROVIDES FOR THE INSTANTANEOUS RECORDING OR READING OF THE
SIGNAL

Fundamental units of vibration equipment. (From *Trouble Shooting with Vibration Equipment.*)

pitch, roll, (11) pressure variation, (12) air speed or in general translational velocity. In fact, any dynamic or static condition, for which a satisfactory pickup can be designed which will emit a corresponding signal, can be recorded. The ease with which phenomena may now be recorded simultaneously on the same record is extremely important because it provides accurate correlation. The amplifying and indicating units can be standardized, *changes being made only in the pickup unit* to accommodate the kind of phenomena to be investigated. For "trouble shooting" where a universal type of equipment is necessary, electrical equipment is most satisfactory. Mr. Hawkins shows that there are three different kinds of pickup, amplifier, indicator systems.

Measurement of Stresses in Aircraft Propellers

One of the most valuable additions to experimental engineering in recent years has been the measurement of resistance, steady and transient, by means of resistance type gages. E. F. Shelley (Project Engineer, Propeller Division, Curtiss-Wright Corporation), in his paper "Measurement of Steady and Vibratory Stresses in Aircraft Propellers," presents a well-rounded account of a recently developed instrumental technique which he defines as a method of precision electrical measurement, known as "steady-stress insertion," which permits the continuous and simultaneous recording of steady and transient stress components, as well as vibratory stress components, present in rotating propellers under flight conditions. The technique makes use of the conventional resistance-capacitance (a.c.) amplifier and a strain or stress gage bridge system excited by direct current. Mr. Shelley lists five primary requirements to be met:

(1) The simultaneous recording of a large number of total (steady, transient, and vibratory) stress waves.

(2) An adequate sensitivity for the measurement of both steady and vibratory components; in general, a higher sensitivity is desirable in the measurement of vibratory components since they tend to become significant at a lower absolute level than do the steady components.

(3) Provision for varying the effective sensitivity of the vibratory and steady-stress circuits independently.

(4) High order of stability in the entire system to eliminate the need for constant calibration or zero correction.

(5) General considerations of weight, space, ruggedness, and simplicity of operation and maintenance which apply to all equipment designed for use on aircraft in flight. To meet these five requirements a new system has been developed. This system is referred to as steady-stress insertion and its operation is explained.

The author then describes the special equipment needed and gives the equations relating stress to resistance. A thoughtful section entitled "Interpretation" discusses the integration of the principles of the insertion system, so as to cover the *entire* frequency spectrum involved in aircraft stress investigations. Certain limitations and difficulties and temperature effects are also frankly discussed, as well as weight, installation, and complexity. Application is now possible in many aircraft problems outside of the propeller in rotating wings, in the fin of a dive bomber, in many other nonrotating aircraft structures. In the aircraft propeller itself many parameters can be studied, such as blade angle, blade twisting moment, torque, as well as steady and vibratory stresses.

Resistance Wire Strain Gages

Mr. Shelley in dealing with the use of the strain or stress gage in measuring stresses in aircraft propellers was concerned with one of the primary uses of the strain gage in aeronautics. But this technique has now advanced to such a point that it offers possibilities in secondary force-measuring systems, such as wind-tunnel balance systems, the measurement of moments in the wind tunnel, etc. W. C. Randels and V. C. Plane (North American Aviation, Inc.), writing on "Force Measurements by Means of Resistance Wire Strain Gages," provide an excellent guide to those working in this secondary field. Forces can be measured by springs whose deflection is measured by resistance wire strain gages. Two types of springs are commonly used, the cantilever beam and the ring. Of these, the cantilever beam offers more effective use of its surface area and usually presents no installation difficulties. This paper is confined to the discussion of cantilever beams. A constant strength beam of parabolic shape has the advantage that the average strain is equal to the maximum strain. In practice, two points are chosen on the parabola and a straight line drawn between them. For design purposes, it is sufficient to use the formulas for a constant strength beam. The formula for stress in a constant strength beam and corresponding formula for deflection are given and graphed for use in designing these beams. Several useful electrical circuits are presented and analyzed. The results of some experiments on the effect of working voltage and temperature are also presented.

Flight Test

The session was indicative of the refinement that flight-test engineers bring to their task in the reduction of performance data to standard conditions and in the correction of instrument errors. There were also reports of noteworthy progress in the use of flying models and in long-distance control and instrument indication.

Reduction of Flight-Test Data to Standard Conditions

J. G. Beerer (Assistant Chief Technical Engineer North American Aviation, Inc.) was responsible for a new principle in his paper "The Reduction of Flight-Test Performance Data to Standard Air Conditions by the Temperature Altitude Method." Every method advanced to date for the correction of observed performance to standard has been based on the assumption that airplane and propeller characteristics are not affected by the compressibility of air. As a result, current correction methods give unsatisfactory results when used to establish the standard air performance of modern high-speed airplanes. The advent of the gas-turbine jet-propelled airplane has further emphasized the need for a new method. In this paper a method of correction is suggested which allows for the effects of Mach Number on the airplane, propeller, and engine characteristics. This method is called the "temperature altitude" method because it corrects the airplane performance at the observed ambient air temperature for the variation of air pressure from the standard value corresponding to the observed temperature. Therefore, the basic variable governing compressibility effects on the airplane, the speed of sound in air, is held constant between observed and standard air conditions. The method is applicable to airplanes driven by Otto cycle engines and propellers, by gas turbine engines and propellers, by gas-turbine jet-propulsion engines, and by combinations of these types of engines. While intended principally for high-speed airplanes, the method is applicable to airplanes of all speed classes from low Mach Numbers up to and including supersonic flight velocities. The analysis and proof of the temperature altitude method is somewhat lengthy but the routine application of the method to the reduction of observed flight data is of extreme simplicity. Three examples of application are given: (1) propeller driven by supercharged engine, (2) gas-turbine jet-propelled airplane, (3) propeller driven by gas turbine. In the first two cases experimental verification of the method is available. In each application the author has shown himself thorough, studying the effect of air pressure systematically on engine performance, exhaust jet performance, propeller performance, reduced altitude, reduced true air speed, reduced manifold pressure and temperature, etc.

Air-Speed System Errors

The determination of true flight air speed is all the more important today because of the high speeds of modern

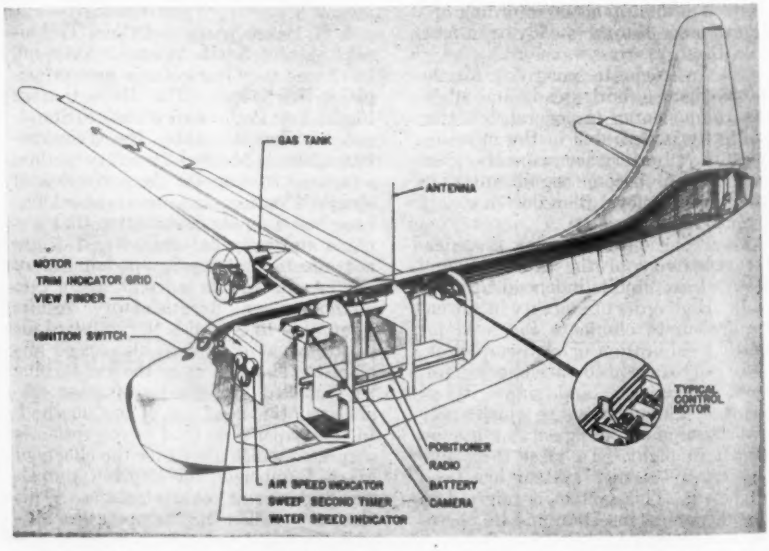
flying and of compressibility. Herbert R. Crawford (Chief Flight Test Engineer, Grumman Aircraft Engineering Corporation), in his paper on "The Determination of Air-Speed System Errors," presented a comprehensive review of the calibration of pitot-static airspeed systems. The errors to which these systems are subject were discussed and evaluated. Steady-flight air-speed calibration methods were described in detail, and an abbreviated treatment of dynamic air-speed calibration was included. Related subjects such as instrument calibration, choice of test equipment, and dynamic balancing of the air-speed system were also discussed. Besides his excellent and "conventional" treatment of the subject, Mr. Crawford presents a number of new techniques. For example, he discusses speed measurement in maneuvers "for tests in which airspeed determination is critical, such as demonstration dives of military airplanes, further steps must be taken to obtain accurate readings. One satisfactory method for accomplishing this end requires the use of a test airspeed system with a remote-indicating airspeed unit located in the immediate vicinity of a combined pitot-static tube. In this arrangement the volumes of the total and static systems are small, and any existing lag is usually a function of the instrument itself. If negligible error due to lag in the test system is assumed, a comparison of the test and standard airspeed readings will provide a basis for lag 'calibration' of the standard system. Of course, the test-system as well as the standard-system position error must have been previously determined." But it is in the paragraphs dealing with Future Developments that we find maximum interest.

"The use of electronic equipment for airspeed determination falls into two classifications: (1) use of the equipment as a primary means of airspeed measurement; and (2) use of the equipment for the calibration of ordinary pressure-type airspeed systems. The advantage of a means for directly measuring airspeed electronically lies primarily in overcoming the difficulties encountered at transonic and supersonic speeds with the pitot-static airspeed system. The author has heard of one proposal for possibly accomplishing this end. This method would involve the periodic ionization of free air particles by an electronic device housed in the airplane. These charged air particles would flow aft, and as they pass another point on the airplane, would be detected by a second device. Since the distance between the 'transmitter' and the 'receiver' is fixed, the time required for its traverse by each air particle would be a measure of the true airspeed of the airplane. The perfection of any such method would, of course, depend upon the development of equipment capable of ionizing air particles at a distance and other equipment capable of detecting the presence of the particles. The flight calibration of ordinary airspeed systems by means of electronic equipment also falls into two classifications. The first includes those methods in which ground speed is measured electronically, and airspeed is determined using the principles of the speed-course calibration method; the second classification includes methods in which airspeed is measured directly. Most of the electronic methods used at present fall into the first category. These methods include the use of fixed vertical radio beams as the end points of a speed course; the measurement of ground speed by means of the Doppler effect, as applied to radio signals; and other similar methods. In the second category, a possible means of calibration might be developed in which true flight airspeed is determined by measuring with radar equipment the relative speed between the test airplane and a free-floating metal-foil-covered balloon. While these methods may seem unduly complicated when judged by current standards, it is very probable that some of them will be specified as standard test procedure for future high-performance airplanes."

Dynamically Similar Flying Models

In the early development of the airplane, flying models played almost no part. With the helicopter flying models have proved more useful, and in recent flying models of airplanes are attracting greater attention because of the cost and size of the full-scale aircraft. Therefore, a paper by Ernest G. Stout (Design Specialist in Charge of Hydrodynamics, Consolidated Vultee Aircraft, Corporation), on "Development of Precision Radio-Controlled Dynamically Similar Flying Models" is timely. Mr. Stout summarizes his purposes exceedingly well. "This paper describes the development of a procedure whereby flying scale models, which are dynamically similar scale duplicates of the full scale prototypes, may be accurately flight tested through the use of positioning, multi-channel, radio remote control. This development allows the designer to accurately determine many dynamic characteristics of a new design which would not ordinarily be available until the actual airplane is flight tested. This procedure is particularly well adapted to the determination of dynamic stability during the takeoff and landing of flying boats and was primarily developed for this purpose. However, it is directly applicable to many other dynamic problems of both landplanes and seaplanes." The difficulty in studying the stability in take-off or landing of a flying boat by dynamic models in the towing basin is that partial restraint of some nature has been necessary. Attempts have been made to give dynamic models of seaplanes freedom about all three axes, and even fore and aft freedom, but the results have not proved fully satisfactory when any more than freedom in rise and pitch is allowed. Even here the rise is so limited that the models can no more than just take off and the fore-and-aft acceleration is that impressed by the rigidly connected towing carriage. In addition, all forms of partial restraint restrict all sideways motion precluding any investigation of dynamic directional stability.

There is full justification for dynamically similar flying models remotely controlled. Mr. Stout gives some interesting points in the design of a one-eighth-scale Consolidated Vultee Model 31 twin-engined flying boat, equipped with two, 2-cylinder 2-cycle gasoline motors rated at 4,250 r.p.m. The model is constructed of $^1/_{16}$-in. skin, balsa monocoque planked onto $^1/_8$-in. plywood bulkheads. The wing is equipped with full-span, dural leading edge slots which compensate for scale effect on lift



Cutaway inboard profile of model flying boat showing the relative locations of the various pieces of equipment. (From *Development of Precision Radio-Controlled Dynamically Similar Flying Models.*)

due to Reynold's Number. The weight of the model complete with engines, propellers, fuel, radio receiver, servos and batteries is 78 lbs. or 40,000 lbs. full scale. Speaking of the power plant, the author says that in the case of free bodies it was not possible to use the special variable frequency electric motors that had been developed for the partially restrained towing basin models. After careful study it was decided to develop a special two-cycle gasoline engine for the job, and Ohlsson and Rice Manufacturing Company engines which were to fit into a 9-in. cowl, weight approximately 3 lbs., deliver $1\frac{1}{2}$ b.hp. at 5,000 r.p.m., and have complete throttle control from idling to full throttle. The power-plant installation weighs 8.0 lbs. complete per nacelle. This weight includes the engine, propeller, coil, gasoline tank, engine mount, fire wall, servomotor, and cowling. The engine has a displacement of 2.77 cu. in. and an overall span of 9.5 in. including the spark plugs. In regard to the servo system the elevators, rudder, ailerons, flaps, and independent throttles are operated by small, electric positioning servomotors. These servos are five-pole, split field electric motors geared to a jack screw and rated 1 amp. at 6 volts. All servos are equipped with potential dividers which position the servo proportional to the modulated audio signal. Each servo contains a homing circuit and, in case of emergency, the transmitter is turned off and all controls on the model home to a predetermined position of gliding flight with idling propellers. If the pilot so desires, he may switch the transmitter on again and pick up control of the model. This is also a safety feature which automatically comes into action should the transmitter fail for any reason. For the radio control the transmitter is built in the form of a full-scale flight deck with adjustable pilot's seat, full-scale flight controls, and is highly mobile. The transmitter is four-stage, crystal-controlled and has a 63-watt output. The single R.F. carrier carries 7 audio frequencies corresponding to the seven primary remote-control channels. This allows simultaneous and independent control of flaps, ailerons, rudder, elevator, two throttles, and ignition. The position of any control is determined by the modulated amplitude of the corresponding audio frequency. The pilot's control wheel is equipped with a micro thumb switch which engages the autopilot. It is possible to fly the model manually and, at any time at the press of this switch, to engage the autopilot to hold any stabilized position. With the autopilot engaged, the rudder pedals are disengaged and the pilot's wheel controls the model through the gyro. The radio receiver consists of the pickup, filtering, modulation, and relay circuits. This receiver, including the waterproof dural case, weighs 12.5 lbs. complete. The changes in modulation of the audio for any channel operate a sensitive micro-relay with the plate voltage. This relay, in turn, operates a power relay which carries the servo current. For recording movements a good moving picture camera and a special film analyzer based on theories of descriptive geometry dealing with the relation and proportionality of true length to foreshortened gave, in combination, a highly successful system. Correlation with towing basin methods was well established and the new equipment and model justified themselves completely. Mr. Stout's final conclusion is:

"While the studies discussed herein have applied to a fixed ground-control station and apply principally to the dynamic stability of seaplanes during take-off and landing, the application to other problems of dynamics is apparent. From a technical standpoint it is entirely feasible to operate the transmitter while air-borne thus extending the altitude and range of operation. These and additional applications are currently under development. With the full development of this procedure it will be possible to determine the dynamics of a new design with the same ease and accuracy as the statics are now determined in a wind tunnel."

Radio Telemetering

In many instrumentation systems it is desirable or necessary to have an indication of the measured value at some distance from the point of measurement. This is particularly true in aircraft flight testing, or in the flying of radio-controlled aircraft. In installations of this type it is frequently advantageous for reasons of safety to remove all personnel from the aircraft being tested or flown by radio control systems. It then becomes necessary to have a means for reading the flight instruments, particularly at some remote point. David William Moore, Jr., and Frank G. Willey (Engineer in Charge and Project Engineer, respectively, Fairchild Camera and Instrument Corporation), in their paper on "A New System of Radio Telemetering," describe a telemetering system that permits reading a standard aircraft instrument with slight modification to the instrument itself, transmitting this reading to any desired remote position or positions and reproducing faithfully the initial indication on a dial equivalent to that of the aircraft instrument.

The problem first undertaken was the transmission of the indication of a standard sensitive altimeter. As a continuous indication was required, all of the step-by-step impulse systems were eliminated and it was decided to use electrical phase angle as the transmission means. An instrument indication pick-up was designed which coupled magnetically to the sweep pointer of the sensitive altimeter, and which shifted the phase of its input signal degree for degree with the motion of the sweep pointer. The pickup was designed to mount directly on the sensitive altimeter and no alterations were necessary other than the mounting of a small permanent magnet on the hub of the sweep pointer. This magnet enabled the use of magnetic coupling to the position pickup and the maintaining of the pressure seal of the instrument. The position receiving instrument was an electrical phase angle meter with a power output connected to a pointer system similar to that in the original altimeter. The paper presents schematic wiring diagrams from which the operation of the entire system, covering reference signal, intelligence signal, audio frequencies, rectification, filtration, etc., can be seen. Finally the system arrives at an appropriate 500-cycle transformer and two-phase motor. The two-phase motor develops torque when there is any phase angle difference between the current in phase one and phase two, this difference having its origin in differences between reference signal and intelligence signal.

Safety

The Safety Session brought encouraging evidence of the greater attention that is being given to cockpit design. Improvement in the cockpit may limit to annoyance and expense a crash that might otherwise lead to a fatal accident. The keynote of the rest of the safety session was that government regulations were but a fraction of what is needed for safety. Effort well beyond government requirements should be made by operators and manufacturers alike.

Civil Air Regulations

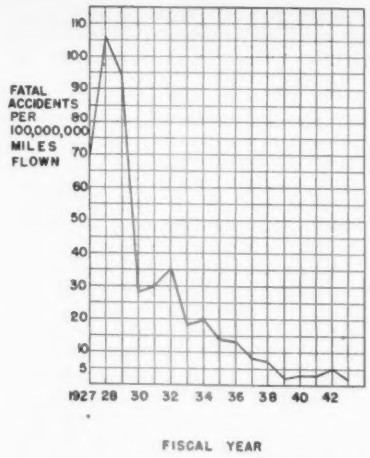
On the whole C.A.B., C.A.A., and Air Transport operators work well together toward the common goal of greater safety, and the study by Robert C. Loomis (Director of Base Engineering, Transcontinental & Western Air, Inc.), on "Effect of Recent Changes of Civil Air Regulations on Safety" confirms this view. In this paper recent changes in the Civil Air Regulations are reviewed for their effect on the operating safety of passenger transport aircraft designed for use by scheduled air carriers. The most significant change is the one eliminating arbitrary upper limits on the stalling speed of aircraft. Inasmuch as the Civil Air Regulations are primarily designed to promote safety in transport aircraft, many groups have questioned this change in the light of its effect on safety. It is pointed out that the regulations guarantee an adequate margin of performance regardless of aircraft stalling speed. High operating speeds in themselves are not to be feared provided adequate airport space is available and provided adequate operating rules are promulgated. When the effects of winds and vertical air currents are considered, it is shown that increases in operating and approach speeds actually increase safety.

The new regulations also include new stability and control requirements that will have important favorable effects on the safety of transport aircraft. The net effect of all the new regulations will be greater safety for the American air-traveling public.

Cockpit Design

Accidents and crash landings cannot always be avoided but of recent years research in Bromechanics has led to the conclusion that the results of crash landings can be made less injurious to personnel. A paper by Hugh de Haven (Research Associate, Department of Physiology, Cornell University Medical College), on "Crash Research from Point of View of Cockpit Design" is a notable addition to the subject. In transport aircraft safety records are good because accidents are forestalled by care and experience in operations. In personal flying, lack of experience—plus poor judgment, carelessness, and technique—sets up a costly and increasing number of accidents. Pilots take most of the blame, but aviation takes heavy unseen losses. "Spin-proof" planes will reduce present rates of vertical, hopelessly extreme crashes in popular flying. However, if hundreds of thousands of inexperienced pilots handle easy-to-fly planes, large numbers of serious mishaps will occur in which the difference between fatal injuries and moderate injuries will depend largely on cockpit safety and cabin design. Research on crash injuries has uncovered unexpected possibilities of crash protection. When the war started it seemed doubtful that much could be done to alter the results of severe aircraft accidents. It was generally believed that the overall violence of a crash would cause internal injuries and that puncture injuries of the body would be common. There were also widely accepted rumors that shoulder harness broke pilots' necks and that "thousand-pound" safety belts cut people in two under severe conditions. Crash studies showed that these beliefs were unfounded and that the body's ability to withstand crash force was seriously underrated.

Data now available indicate that, except under the most extreme conditions, the severity of injuries in an accident is not a direct function of crash force. In accidents where cabin structure has not collapsed, fatal injuries are principally head injuries caused by striking dangerous objects such as throttle knobs, control wheels, heavy instruments and instrument panel assemblies. Safety has been overlooked as an essential factor in the design of many cabin details. With improved understanding of injury causes, valuable increases of safety can be provided without material differences in cost, weight, or appearance. This paper discusses typical causes of injury along with proposed improvements that will lessen dangers in future types of aircraft for popular use.



Summary of United States carrier accident record from 1927 to 1943. (From *Effect of Recent Changes of Civil Air Regulations on Safety.*)

An Air Safety Program

Amos L. Wood (Chief, Accident and Operations Analysis, Boeing Aircraft Company), discussing the "Organization and Utilization of an Aircraft Manufacturer's Air Safety Program," illustrates splendidly the point made by W. E. Koneczny that aircraft manufacturers can go much further than required by Civil Air Regulations in promoting airplane safety. Boeing Aircraft have by studying accidents, by utilizing findings in aircraft design problems, and by releasing their experience, will encourage other manufacturers to undertake similiar projects. The first part of the paper deals with the organization of an Air Safety Program, and creation of an Accidents and Operations Analysis staff. The Analysis Staff acts as a two-directional channel between the design engineers and the operators. In one direction goes all statistical and accident information which is directed to Engineering Division Supervision. In the other direction go questions to Field Representatives for information permitting the Engineering Division to accomplish necessary preventive action. Since gathering accurate data is one of the most important functions of a safety program, the methods of obtaining information are discussed. The majority of data obtained for postaccident analysis is received from the field representatives. An incident that is a potential accident is reported as a *near-accident*. Special accident report forms are used which allow the investigator freedom to report his version of the accident and yet insure by entry blanks that all routine pertinent data are furnished. To obtain the most accurate data from accident investigations, field representatives are given special instructions as to what to look for at the scene of the accident, how to interrogate witnesses, and how to conduct the investigation. A complete analysis of each and every accident has been the chief means of establishing probable causes and contributing factors of aircraft accidents. In one B-29 accident a seemingly unimportant detail reported by a field-service engineer and noted by the accident analyst subsequently proved to be the key link in establishing the most logical solution to eleven similar accidents. After describing methods of cooperation with A.A.F. and statistical control, Mr. Wood goes on to "Utilization in Design" on the basis of information gained. Accident preventive design is possible, purpose of which is to minimize personnel errors by forecasting how a crew member is apt to operate, maloperate or abuse a new piece of equipment or basic aircraft development. Some most illuminating passages appear in Mr. Wood's paper. "Wartime operation of military aircraft has convinced this manufacturer that the design must embody the absolute of simplicity in operation. For example, our studies of B-29 accidents indicate that the *average pilot and crew* can meet normal operations satisfactorily. However, this same *average pilot and crew* often have difficulty meeting a single emergency. The B-29, a highly specialized bomber, has presented not only double emergencies but triple and quadruple emergencies. Accidents to four-engined aircraft, however, seldom happen as the result of a single pilot or material failure. There is usually a progression of errors. One case in our files shows that a pilot committed eight different errors before the final plunge."

The utilization of this remarkable program has led to some valuable results which are summarized as follows:

(a) Accident-free designs through advance analysis.
(b) Prediction of accident rates and types.
(c) Revisions to aircraft already delivered.
(d) Safety eduction to the operator.
(e) Ground safety considerations.

While the program functioned in wartime, and military aircraft and operations were studied accordingly, there is

The above illustration shows a suggested method of protecting a pilot against crash injury by providing a rugged, resilient wheel to distribute loads on the chest and some form of inertia mechanism to prevent rapid forward movement of the push-pull tubes. (From *Crash Research from Point of View of Cockpit Design.*)

every reason why similar activity in commercial aviation should be undertaken.

Safety Beyond Regulatory Requirements

Civilized society functions with the aid of unwritten laws far beyond the scope of legislation, and W. E. Koneczny (Safety Bureau, Civil Aeronautics Board), presented an analogous situation in "Safety Beyond Regulatory Requirements." Civil Air Regulations cannot, and should not, cover all matters influencing safety in the air. There remains unregulated by the Civil Aeronautics Board a broad field dealing with safety which can be dealt with more efficiently by other than regulatory means. A study of records of aircraft accidents reveals many instances in which design practices or operational procedures not covered by C.A.R. were directly or indirectly responsible. Mr. Koneczny gives some interesting illustrations of his basic thought. For single-engined aircraft it is required that the minimum rate of climb for landplanes be at least 1:12, and during takeoff the minimum speed of the airplane when at an altitude of 50 ft. above the runway must not be less than 30 per cent higher than the stalling speed. But an airplane just meeting the minimum requirements would be considered underpowered with little safety margin in other than ideal operating conditions. Hence the desire of pilots for a higher margin of safety during take-off and initial climb, and manufacturers obligingly are offering products with this margin of safety in mind. Another example lies in endurance. The minimum range and minimum endurance are specified by requiring a minimum capacity for the fuel tanks equal to 1 gal. for each seven rated horsepower of the engine or engines. This is equivalent at an average to an endurance at cruising speed of about 2 or $2^1/_2$ hours. An aircraft barely meeting this requirement would not be suitable for cross-country operation. Here again the manufacturers, realizing the importance of range and endurance, make provisions for a much greater fuel capacity than called for in C.A.R. Again, while there is no regulation prescribing limits on cruising speed, the choice of a speed that gives the engine less wear is highly desirable.

Stall speed, no longer prescribed for transport aircraft also offers scope for intelligent selection. There are no regulations for stability and controllability but the designer should and does seek stability without impairment of maneuverability and controllability. The author brought up a less well-understood topic "Controlled Failure Design."

The general purpose of controlled failure design is to distribute margins of safety within the structure so that, when an overload condition occurs, any failure will be at a relatively inconsequential point. Such a point, for example, may be in the landing-gear structure, with the adjacent wing structure made correspondingly stronger. Proper distribution of margins of safety along the span of the wing is another opportunity for controlled failure design. Mr. Koneczny rightly believes that the scope of detail design is so broad that any regulation can include only the minimum requirements for safety. One of the most obvious examples where the Regulations cannot be specific is that of cockpit vision. Considering the importance of the best possible cockpit vision, much more effort than heretofore must be made by the manufacturer in this phase of design. The qualities of windshield material also deserve serious attention. With increasing cruising speeds, the danger of bird strikes increases and the necessity for additional strength of windshield material becomes obvious. Designing of efficient material is further complicated by the necessity of reconciling strength, retention of transparency, good refractive features, and possible defrosting provisions, while simultaneously keeping the weight at a minimum. Much can be accomplished toward safety by efficient design of doors and emergency exists, but mere compliance with the Regulations does not insure the best possible design and lives have been lost because of the inadequacy of emergency exits that have an uncanny way of jamming just at the time when they are most needed.

One fairly recent accident in which 20 people lost their lives serves as an outstanding example. Most of the bodies were found burned in the rear of the cabin where apparently an unsuccessful attempt was being made to open the main door. Other points similarly treated were crew accommodations; cockpit location, equipment, and soundproofing; protection of crew in case of a crash; floor design; fire prevention and fighting; and design of fuel tanks. Operation, including qualifications of certificated personnel, is much less susceptible to detailed regulation than design of aircraft. Consequently, pertinent parts of the C.A.R. are much less specific, leaving much of the responsibility for safety to those directly concerned. Admittedly this responsibility is grave and requires sound judgment from the individuals in exercising their operating privileges. A thoughtful paper of this character is highly welcome, bringing home to great segments of the entire aviation industry that their responsibility for safety lies well beyond government regulations.

Air Transport

The session served notice of efforts to make all-weather flying possible and drew attention to the great developments in airport construction and to the urgent need of training in airport design.

Design Considerations for a Modern Transport

Frank W. Fink (Chief Engineer, San Diego Division, Consolidated Vultee Aircraft Corporation), dealt authoritatively with "Design Considerations and Developments for a Modern Commercial Transport." Design considerations for a modern transport can be grouped in three main categories, namely; safety, economy, and passenger appeal. Those considerations pertaining to safety include performance with one engine inoperative, stall characteristics, dual wheel landing gears, reversible pitch propellers, and fire hazards, both in flight and on crash landings.

Considerations having to do with economy are maximum possible percentage of pay load, maximum cruising speed, and minimum ground handling time, both during operation and overhaul. Considerations having to do with the passenger appeal include overall appearance in both interior and exterior, good vision, low noise and vibration levels, seat comfort, interior arrangements, and items that tend to speed up loading and unloading of passengers and their baggage.

All-Weather Flying

The Army, with General Curtis LeMay taking the initiative, is making a great effort to secure all-weather effort. Col. E. E. Aldrin (Air Corps, All Weather Operations, Wright Field reported progress in his paper "Fair to Foul Weather Flying." The progress of the A.A.F. in attacking all-weather flying has been slowed down due to the changeover to peacetime tempo. A real advance was made when it was decided to concentrate all aids at one location, Lockbourne Army Air Field, and there evaluate them, using all types of military aircraft. There is no one cure-all for the problem. Radio and radar have their usefulness but also their limitations. The principal difficulties at present are traffic control, icing, and automatic flight. As much of the Air Force program will be discussed as may be of interest to civil aviation.

Airport Design Problems

Robert Kerr, Jr. (Chief, Airway and Airport Engineering, American Airlines, Inc.) in "Runway Layouts and Related Airport Design Problems" presented a paper of which the author's own summary was excellent. As one of the important aeronautical sciences, Airport Engineering has not received in the past sufficient attention to keep it abreast of the progress in Aerodynamics and Aircraft Design. All organizations interested in promoting aviation, including technical colleges and universi-

ties, should realize the need for development of standard design criteria and construction practices for airport facilities.

To create and maintain the maximum demand for private and commercial aircraft, it seems advisable to urge early completion of the national airport program so that the nation may reap the full potential benefits of air transportation as soon as possible. The demand for competent airport engineers will certainly be enormous in the next few years. Aircraft engineers and manufacturers can greatly assist the airport planners by circulating advance information on future aircraft design and particularly probable maximum gross and landing-gear wheel loads. Except on flat terrain in rural regions, each runway layout constitutes an individual problem. This calls for ingenuity and practical judgment on the part of the airport engineers. Since great increases in the volume of air traffic of all categories are anticipated, one of the most important considerations in airport planning is provision for expansion of all elements of an airport as the demand develops. Generally, this involves adequate clearances and calls for liberal allowances in area for future expansion. Public officials must have foresight and courage to recommend adequate initial expense for sufficient land acquisition to insure long-range economy.

Meteorology

Two sessions were held in cooperation with the American Meteorological Society. In the absence of preprints of papers, only edited accounts of the brief summaries offered by authors themselves are included here.

Radar Storm Detection

In "Radar Storm Detection," by Lt. G. E. Austin (Headquarters, A.A.F. Weather Service), the author discusses theoretical aspects of radar echoes from meteorological phenomena and operational utility of radar weather data, and shows selected illustrations.

Radar Exploration of a Hurricane

The interpretation of certain specific features of the radar scope pictures appearing in the film *Radar Exploration of a Hurricane*, is discussed in detail by Lt. Col. H. Wexler and Lt. E. G. King (Headquarters A.A.F. Weather Service). Of particular interest is the interpretation of the concentric so-called "squall lines" that appeared in advance of the hurricane. It is believed that these "squall lines" are not necessarily rain areas of the surface, nor does the scope necessarily show all surface rain areas. The lack of coincidence of the radar indicated storm centers and low-pressure centers has not been adequately explained but raises several interesting hypotheses.

Typhoon Reconnaissance

"Typhoon Reconnaissance by Navy Search Aircraft June Through September, 1945" by Lt. Paul A. Humphrey (U.S.N.R.) is a compilation of the experiences of Navy aerologists during more than 100 typhoon reconnaissance flights aboard special naval search aircraft covering the China Sea and extreme Western Pacific. An overall picture of this spectacular phase of aerological work is briefly given together with the most important details of the initiation of these specialized searches. This is followed by an illustrated account of the most interesting storms flown and a brief summarization of the more important meteorological and oceanographic facts so far obtained. The accomplishments of typhoon reconnaissance with regard to naval operations in the Western Pacific and remarks concerning the future of this type of aerological technique conclude the presentation.

Summer Stratus in Southern California

In "Physical Processes Associated with Summer Stratus in Southern California," by M. Neiburger (Assistant Professor of Meteorology, University of California), the typical atmospheric structure over the Southern California coast in summer, an adiabatic (marine) layer about 500-meters thick surmounted by an inversion layer of slightly greater thickness above which normal lapse rate obtains, is shown to be due to the interaction of the circulation of air and ocean.

That the stratus top is practically coincident with the inversion base was corroborated by blimp flights. These flights also verified the upward slope of the inversion base toward the sea. Over land the inversion is about level at night and slopes upward inland during the day.

Both the diurnal and the longer period variations in stratus occurrence depend on the temperature at the inversion base. The principal factors affecting the diurnal variation are sea-breeze convergence and insolation. The longer period variations are due to changes in the large-scale circulation. Stratus is completely absent when the air subsides from the coastal mountains, bringing the inversion down to the surface.

The diurnal variation of pressure was analyzed at various levels and various stations to study its effect on the airflow.

The insolation effective in dissipation of stratus depends on the albedo of the cloud. Observations show that for thin clouds, up to 1,000 ft., the albedo varies rapidly with cloud thickness, in accord with theory. The albedo also depends on drop size and water content. Measurements indicate that the drop diameters in coastal stratus are most frequently about 15 microns, with no systematic variation with cloud thickness or position in the cloud. The water content usually is a maximum (about 1 Gm. per cu.m.) near the cloud top, decreasing roughly linearly to the base.

In conclusion, the application of the analysis of the various physical processes to the forecasting of stratus formation and dissipation is discussed.

Automatic Weather Stations

The paper "Automatic Weather Stations," by Louvan E. Wood (Friez Instrument Division, Bendix Aviation Corporation), contains a description of "Automatic Weather Stations" with regard to their characteristics, current state of development, and future possibilities. Active development of an automatic weather station, sponsored by the Bureau of Aeronautics of the U.S. Navy, was started in 1939 by the Radio Section of the National Bureau of Standards. Upon successful demonstration of this development, a complete station was built by the Friez Instrument Division for the Navy. Subsequently, a number of stations of a further improved design have been constructed. Other types of stations have also been developed, and various organizations have contributed to this work.

The Navy-type station is described in some detail. Other types of stations are mentioned, and applications for weather stations in general discussed.

Wartime Developments

"Wartime Developments in Aircraft Weather Reconnaissance," was presented by Capt. George E. Forsythe (Headquarters, A.A.F. Weather Service). Aircraft weather reconnaissance has become such an increasingly important tool of the weather services that it may be considered a separate branch of meteorology. Four types of military weather reconnaissance, not mutually exclusive, have been defined: (1) target and combat route reconnaissance; (2) ferry and transport route reconnaissance; (3) area, base, and patrol (including hurricane) reconnaissance; (4) synoptic reconnaissance.

At least ten types of military aircraft, from P-38's to B-29's have been assigned to weather reconnaissance. The choice of aircraft is an important matter. The observations taken aboard these aircraft require the full time of a specially trained meteorologist because of the specialized character of the equipment and techniques used. The qualitative observations are not unlike the analogous ground observations but also include several items peculiar to aircraft; moreover, considerable judgment is needed to present a representative picture of the weather in the periodic messages. The taking of quantitative ob-

servations—pressure, temperature, humidity, winds, altitude, cloud heights, etc.—not only entails painstaking use of much special equipment, but also requires sound knowledge and meticulous care in correcting errors caused by the motion of the aircraft.

A.A.F. Weather Service Manual 105-128-1, *Aircraft Weather Reconnaissance* (unclassified), is a preliminary textbook on reconnaissance, based on the experience and research of the Army Air Forces.

Thunderstorm Structure

"A Project on Thunderstorm Microstructure," was reported by Horace R. Byers (Director, Thunderstorm Project, U.S. Weather Bureau), Col. B. G. Holzman (Headquarters A.A.F. Weather Service), and Comdr. B. H. Maynard (U.S.N.). Under special authorization of Congress, the Weather Bureau, with the extensive cooperation of the A.A.F. and the Navy, is this year undertaking a detailed study of the structure and dynamics of the individual thunderstorm. The project, using airplanes, sailplanes, balloons, and radar operated in thunderstorms simultaneously with a micronetwork of autographic-recording surface stations, is aimed at finding methods of circumventing dangerous parts of thunderstorms. Excessive thunderstorm gusts or drafts are recognized as the principal hazard to be dealt with, although hail and lightning also are important in the investigation. The A.A.F. is establishing an airplane and radar program in connection with the project, and the Navy plans to operate "drone" (pilotless) aircraft in thunderstorms. These thunderstorm flight observations will be carried out in Florida and in the Middle West with coordinated balloon, radar, and ground observations.

Radar and Weather

Comdr. R. H. Maynard (U.S.N.) spoke about "Radar and Weather." This paper summarizes, in general, what is known about the aerological aspects of radar in the field of storm detection and in measuring atmospheric elements. The paper contains as much as censorship and security considerations permit. Appearances of various cloud phenomena associated with known types of weather are discussed in some detail. General characteristics of type radars are mentioned in relation to type of weather information desired with postwar application.

Wind Flow

"Some Aspects of Nongradient Wind Flow," by J. R. Fulks (U.S. Weather Bureau), emphasizes the importance of nongradient wind trajectories associated with horizontal variations of pressure gradient. Air having an initial component of motion across isobars toward lower pressure will be accelerated, causing the coriolis force to increase, but the air will continue toward lower pressure if the pressure gradient increases sufficiently along the trajectory. The reverse is true if the initial velocity has a component directed toward higher pressure. The equations of motion may be integrated for some interesting special cases which show that cross-isobar flow may continue in the absence of friction or isallobaric fields for distances of the order of hundreds of kilometers. The result in a *low*, assuming upward motion in the center, is that convergence at lower levels and divergence aloft can take place without frictional or isallobaric effects. In a *high*, the opposite circulation is possible.

Precipitation Static

Lt. R. C. Edwards (U.S. Naval Research Laboratory, Minneapolis Branch) reported on "Weather Aspects of Precipitation Static." This paper deals with the Aerological Section of the Naval Research Laboratory Branch formed under the direction of the joint Army-Navy Precipitation Research Committee. The scope of the program from a meteorological standpoint is discussed in two general groups, namely, present implementation and future plans. Activities of the Aerological Section are discussed mainly under Thunderstorm Research and Snow Research with operational aspects and results discussed in detail.

In addition to the preceding papers, Comdr. K. P. Ryzhkov (Washington Representative for the Soviet Hydrometeorological Service) gave "A Brief Discussion of Progress in Soviet Meteorology," and C. G. Rossby, Lt. Seymour Hess, and Lt. Harold Wagner (University of Chicago) reported on "Atmospheric Waves in the Pacific Northwest."

I.A.S.

National Meeting Schedule

1946–1947

LIGHT AIRCRAFT MEETING

June 13–14 Rackham Educational Memorial, Detroit, Mich.

ANNUAL SUMMER MEETING

July 18–19 Hotel Hollywood-Roosevelt, Los Angeles, Calif.

AIR TRANSPORT MEETING

October 24 Hotel Statler, Washington, D.C.

TENTH WRIGHT BROTHERS LECTURE

December 17 New York, N.Y.

FIFTEENTH ANNUAL MEETING

January 28–30, 1947 New York, N.Y.

Standardization of Navy Cockpit Arrangement

LUIS DE FLOREZ*

Office of Research and Invention

Introduction

GREAT CHANGES have occurred in the structure and performance of aircraft over the past years, yet the influence of tradition is only too evident in the design and arrangements of cockpits of the modern airplane. The stick and pedals have been in use so long that no one has dared disturb them. Early aircraft, because of a single engine, had a blind spot directly forward. This localized the instrument panel in a position that has never varied, even though multiple engine aircraft offer the opportunity of much greater forward visibility. Circular-reading instruments have remained standard, and, regardless of this need for more graphic presentation of flight and engine data to aid the pilot, instruments still read and resemble the time-honored clock. Seats, controls, handles, gimmicks, and sharp corners are retained in the same relation, largely because a pilot, by tradition, ought to be good enough to handle what is there.

The engineer has succeeded so well in improving the performance of aircraft that it is time for him to turn his skill to the improvement of the pilot's performance in order to capitalize on his own mechanical advances.

Combating Fatigue

With the increase of speed, range, and reliability of aircraft, the human being has become outclassed. It is no longer a question of how much gasoline can be carried in a single seater, but rather how long the pilot can fight back fatigue and carry out his mission effectively.

Nor is it any longer a question of how much armament can be carried, but rather of how it can be handled most effectively. Such considerations have forced us to appraise traditional cockpit arrangements.

From the point of view of reducing human fatigue, a more adequate presentation of flight and engine data would go a long way toward increasing the performance of aircraft in every respect.

Work has begun on the standardization of cockpits, including not only studies in arrangements but reconsideration of instruments and controls themselves. Actually, it has not been found necessary to change the working parts of instruments, but rather to present their readings in a more comprehensive manner. Fatigue and uncertainty, caused by constant rigid attention acquired when flying on conventional instruments, are conditions that can be obviated by instruments reading in terms of the equivalent of contact observation.

We have also devised instruments that under dangerous conditions will give automatic warning signals in a fashion similar to the well-known "Landing Gear Warning Device" known as the "Howler." This is a concession to human frailty, although its value as a safety device is not always certain. Shortly after the "Howler" was installed for operational use some years ago, a young pilot was preparing to land with his landing gear folded. Foreseeing catastrophe, the tower duty officer attempted to contact the pilot. In spite of repeated pleas by radio, the pilot came in without benefit of landing gear. When asked in sick bay why he failed to heed the voice warnings, the pilot replied: "How the hell could I hear what you had to say with that damn noise behind me!"

Utilization of Senses Other Than Sight

As the aircraft increases in complexity, other channels of informaton will become necessary to free the pilot's eyes for tasks that no other sense can perform. A study covering the utilization of other senses besides that of sight indicates that sound, in some instances, can be substituted for sight. We are investigating the possibility of homing on a radio beacon or station using a binaural listening method. Using such a system, a pilot hears a radio station more strongly in his left earphone if the station is on his left. As he approaches a course directly toward the station, the sound begins to come into the right earphone, as well as the left. When exactly "on course," the station will be equally loud in both earphones. Since a movement off course of 1° or 2° will give a definite changeover from one earphone to the other, it is possible to fly a course quite accurately by ear and at the same time listen to the station.

The work in this line represents but a small part of an important beginning. It is progressing and will continue even though the war has terminated. Facilities for research and experiment are now available in this field and will be used to their fullest extent.

Cockpit Arrangements

During the last few years cockpit arrangements have been subjected to ever increasing criticism. The increase in the number of controls and instruments to cope with the increasing complexity of aircraft is a familiar trend calling for an integrated plan, which so far has had little freedom.

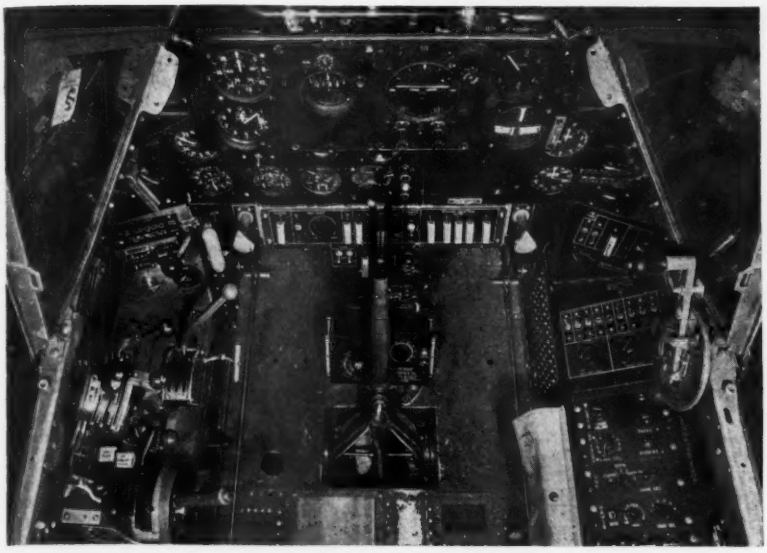
Some progress has been made by individual manufacturers, but existing cockpits leave a great deal to be desired. There is a vast opportunity for improvement in presenting flight data, navigational facilities, radio, and comfort and in the elimination of injury hazards. This is particularly true in fighter aircraft where the pilot has minimum freedom of motion and every inch of space must be utilized to its fullest extent.

In warfare the pilot has more than enough to contend with in the enemy. His combat function must be improved by simplicity of control and indication. The mechanics of flight should be as incidental as possible. Such realization has already brought about considerable change by individual manufacturers, but since these lines of thought have naturally followed separate channels, there has been little or no standardization among aircraft built by different companies for the same duty.

The disadvantages of this unrestricted development became apparent in two of the Navy's present-day fighters and dive bombers. In each type, these aircraft were designed to accomplish the same mission and may be said to have the same engine and propeller and approximately the same gross weight. They both use the same system to operate retractable wheels and to actuate landing and cowl flaps. Each aircraft em-

Presented at the Air Transport Meeting, I.A.S., Washington, D.C., October 25, 1945.

* Captain — now Rear Admiral — U.S.N.R. Deputy Chief.



Present airplane instrument panel.

ploys stick and rudder control and has the identical throttle quadrant and instruments. Here the similarity ends. Instruments and controls vary in appearance, size, and location in almost all planes. Pilots asked, and rightly, why aren't the cockpits the same? The answer is simple, no coordinated effort has been made to standardize cockpits.

This condition accounts for the loss of an untold number of hours spent in reorienting pilots to fly an unfamiliar plane. Check-out procedures and training equipment have been developed to speed up this process, but much unprofitable and expensive time is still consumed in familiarization procedure that is fundamentally unnecessary.

Moreover, under any emergency condition and particularly in the constant emergency of combat flight, a pilot's reactions must be automatic. He employs a series of conditioned reflexes that are interrelated and interdependent. Habit patterns formed on one plane may be strong enough to cause disastrous misuse of controls in a new plane, even after the pilot has acquired a check-out familiarity with it. From this angle alone the importance of standardization cannot be overemphasized.

Cockpit Standardization

Several months ago a joint Army-Navy-National Research Council conference was held to discuss standardization and incorporation of comfort and safety features in cockpits. Although no final official agreement was reached, the Navy set up a project to work along these lines. The cockpit described here is the result of this study. It has been designed by the Joint Aircraft Committee Technical Subcommittee on Cockpit Layout, the Bureau of Aeronautics, and the Office of Research and Inventions. The construction of mock-ups is being carried out by the Special Devices Division of the Office of Research and Inventions and is to serve as a guide and standard for future cockpits.

To achieve results many different mock-ups have to be built, since it has been found that this is one of the best ways of arriving at an agreement among the many people who should be consulted when studying the problem of standardization and maximum utility.

One of the latest twin-engined fighters was chosen as the basic model for research, since it was felt that any satisfactory arrangement worked out for it could be easily adapted to single-engined planes. A wooden cockpit replica was used with mock-ups of all controls and instruments. This made it possible actually to try out changes suggested by civilian contractors and hundreds of pilots from the U.S. Army, U.S. Navy, and the Royal Air Force. Each suggestion was carefully evaluated and improvements were incorporated.

In general, the resultant cockpit is "clean," with all wires and rods console-enclosed. The console height has been carefully calculated for the pilot's arm length. Nothing is out of reach, and no hunched or cramped position is necessary to read and are set so that the pilot can see them at all times without shifting in his seat.

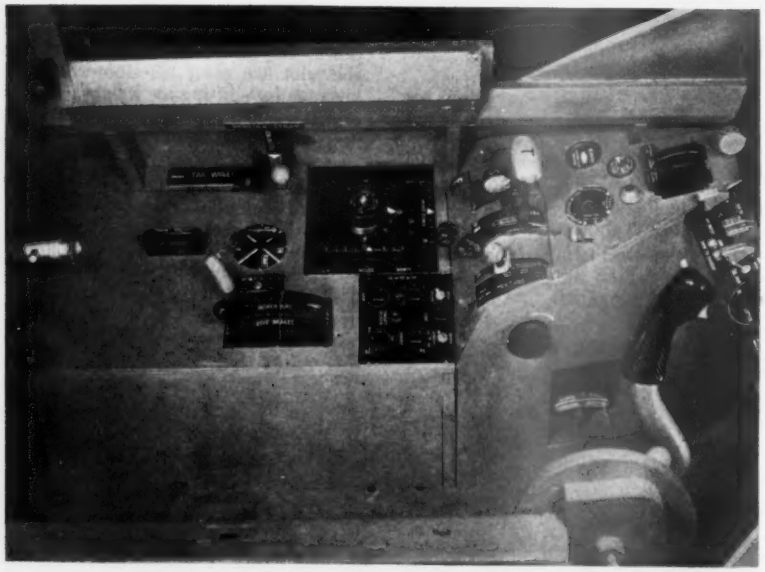
Seat and Harness

The pilot's seat and harness are conventional, with the addition of a hinged elbow rest installed on either side of the seat. When the rests are up, they are completely out of the way. When down, they provide a support on which the pilot can place his elbows and get leverage for shifting his weight.

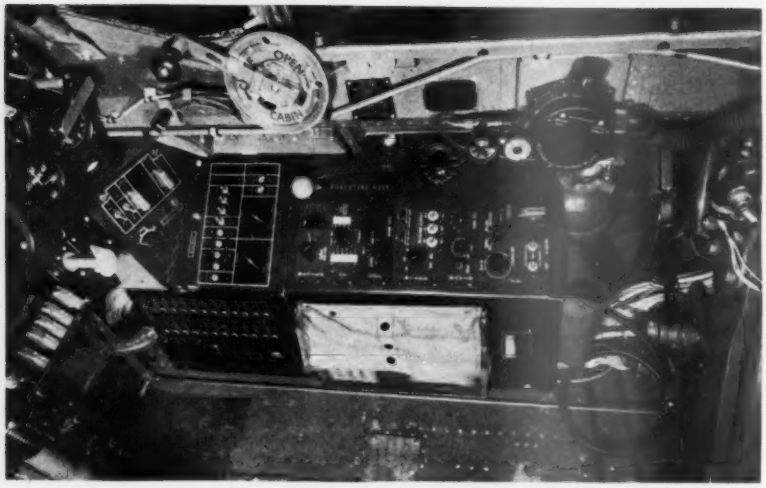
Present aircraft seat designs have been overinfluenced by structural and armament requirements, and it is obvious that there is decided need for further research in order to achieve new standards of seat comfort. The short-range plane of a few years ago no longer exists, and the seat designed for that craft does not meet present and future

Mock-up of proposed instrument panel.

Present airplane left console.



Mock-up of proposed left console.



Present airplane right console.

conditions for ever increasing range requirements and capabilities. Both the Army and Navy are working on designs that will allow change of position and eliminate the acute discomfort of sitting on parachute and boat packs.

Deck Design

A deck is considered essential in the cockpit instead of the usual arrangement of foot troughs. This should eliminate one of the crash hazards inherent in present aircraft. Many accidents have been caused by shoes being caught under a rudder pedal or by objects jamming the controls. With the flush deck it is not possible for foreign bodies to wedge the control mechanism, nor can anything be dropped out of reach. Entrance to and exit from the cockpit are facilitated. Since rigid restrictions are not placed on the position of the pilot's feet, he is more comfortable and more relaxed. In addition, the deck adds to the possibility of lightweight armor protection and has some psychologic advantage from the point of view of fatigue.

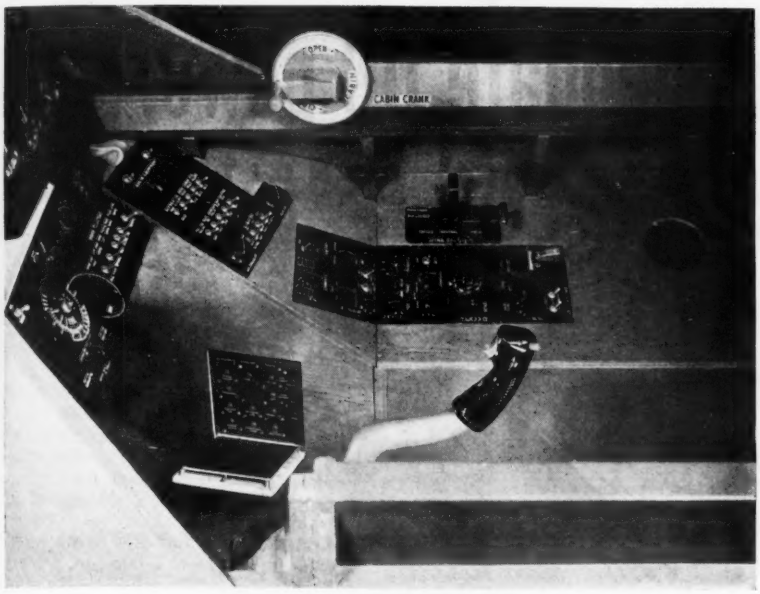
Controls

Controls are designed and mounted to fit normal habit-pattern reflexes. Wherever possible, controls are mounted parallel to the axis, the motion of which they effect. For instance, the elevator tab control is a recessed wheel parallel to the plane's longitudinal axis, so that the natural instinct—forward rotation for nose down—is employed. The aileron tab control, following the same principle, is mounted parallel to the lateral axis and rotates to the right to bring the right wing down. The wing flaps control lever is on a vertical plane—i.e., the lever is up when the flaps are up and down when the flaps are down. In addition, the indication is such that the position of the control itself is identical to that of the flaps. This again incorporates an instinctive motion, and no unnecessary thought is involved as with a horizontal lever.

The exact design of a control is not of prime importance but should embody the following characteristics:

(1) Easy grasp even when the hand is heavily gloved.
(2) Positive action.
(3) Mounting parallel to the axis the motion of which it effects.
(4) Easily visible pointer giving positive indication.
(5) Movement in the direction of the resultant motion.

The center pedestal has been eliminated, allowing more freedom of leg action and change of position. To minimize crash hazards, all edges and corners in the cockpit have been rounded. The control stick has a forward curve virtually eliminating the possibility of chest penetration. The instrument panel is flush. Protrusions have been eliminated; the gun sight does not extend beyond the instrument panel. Wherever injury is possible, switches have been recessed.



Mock-up of proposed right console.

Light Switches

Consideration has been given to the use of a disposable panel containing all light switches and located on the right side of the cockpit above the console. When not in use, the panel folds up against the side and is completely out of the way. This feature is considered desirable, since in many types of aircraft, the bulk of flying is during the day when there is no need for illumination. A shelf, with a writing pad attached, is hinged above the electric light panel and may be pulled down on top of it to provide a handy place for computation. The shelf may also be used as an arm rest.

Controls and switches have been arranged according to the importance and frequency of their use and have been placed, wherever feasible, so that misapplication is impossible. For instance, both the tank and engine selector-valve controls have a closed handle with a red arrow on top. The arrow has sufficient point on it so that the indication can be felt even with gloves on. The OFF position is aft and, when the thumb is on the arrow, requires such an unnatural hand position that any inadvertent switching off of the fuel should be impossible.

Emergency Controls

Particular attention has been paid to the accessibility of emergency controls. For example, the emergency hydraulic hand pump (telescope type) is underhung between the rudder pedals. This position makes it available to either hand in case of injury and gives more room to the seat and consoles.

Conclusion

It is realized that these modifications cannot be expected to produce a perfect cockpit. Furthermore, this project is one that will never be completed, for it must continue as long as changes are made in aircraft and engines. The arrangement discussed here merely represents the completion of the first phase, but it is recognized as a basic pattern for simplification and standardization, for reduction of training time and hazards, and for increase of efficiency.

One of the most important fields of aviation research and development lies ahead—to make new equipment come within the range of human capabilities.

Library Facilities of the Institute of the Aeronautical Sciences

To serve Institute members and others in the aeronautical industry, the Institute of the Aeronautical Sciences offers the facilities of:

The W. A. M. Burden Library
2 East 64th Street
New York 21, N.Y.

The facilities of this library are available for reference study at the Institute.

The Paul Kollsman Lending Library
2 East 64th Street
New York 21, N.Y.

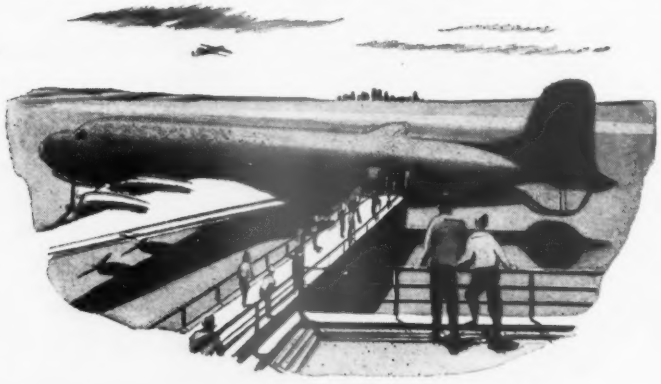
This library loans books without charge to members and others in the United States over eighteen years of age. Full information will be sent on request.

The Pacific Aeronautical Library
6715 Hollywood Boulevard
Hollywood 28, Calif.

This is a service and reference library for West Coast organizations. Full information as to its facilities will be sent on request.

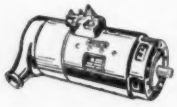
To insure adequate DC power

UNDER ALL OPERATING CONDITIONS



DOUGLAS USES

Eclipse 350 AMP. WIDE SPEED RANGE GENERATOR AND CONTROL PANEL ON ITS MIGHTY TRANSPORTS—THE DOUGLAS DC-6



Full output of 350 amperes available over a speed range of 3500 to 8500 rpm., generator speed. Ample current supply for all DC electrically operated equipment of the aircraft.

Control panel, fully automatic, with carbon pile regulator, automatic compensation for temperature, differential type remote control reverse current relay. Quickly detachable to facilitate maintenance, remotely located for easy accessibility.

Douglas' use of Eclipse* Equipment is the result of years of experience in adopting *ONLY THE BEST* of aircraft accessories. Small wonder then, that Douglas uses Eclipse generators for their mighty transports . . . the Douglas DC-6. Rugged—compact—dependable—and backed by 30 years of generator building experience—they insure adequate DC power *under all operating conditions.*

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Bendix AVIATION CORPORATION

Institute News

Honorary Members Elected

The Council has elected as Honorary Members of the Institute Lt. Gen. Ira C. Eaker, Deputy Commander and Chief of the Air Staff, Army Air Forces; Commodore John C. Adams, President of the Aero Medical Association; and Henry G. Houghton, Jr., President of the American Meteorological Society.

Lieutenant General Eaker formerly commanded the Eighth Air Force and the Allied Air Forces in the Mediterranean. He holds the Distinguished Flying Cross with Oak-Leaf Cluster, the Silver Star, and the Legion of Merit. Commodore Adams, as Chief of the Division of Aviation Medicine, Bureau of Medicine and Surgery, Navy Department, was the recipient of The John Jeffries Award for 1945, given by the Institute for outstanding contributions to the advancement of aeronautics through medical research. Mr. Houghton, who is Assistant Professor of Meteorology at Massachusetts Institute of Technology, was the recipient of The Robert M. Losey Award in 1940, given by the Institute for outstanding contributions to the science of meteorology as applied to aeronautics.

Guggenheim Estate Leased to the Navy

The former Guggenheim estate at Sands Point, L.I., has been leased by the Institute to the U.S. Navy for the Special Devices Division of the Office of Research and Inventions.

Given to the Institute in 1942 by the late Mrs. Daniel Guggenheim, the estate comprises about 160 acres, with buildings.

The Special Devices Division will continue to concern itself with training devices, keeping pace with the development of new weapons and combat techniques. Naval Reserve and civilian scientists and technicians will staff the Division, the Naval Reserve personnel to be gradually replaced by civilians.

Lieutenant General Doolittle Honored by American Legion

Lt. Gen. James H. Doolittle, Vice-President of Shell Union Oil Corporation and a Fellow and Past-President of the Institute, has been awarded the American Legion's Medal of Valor. In addition, he was given a gold life-membership card of the Legion. The presentations were made at a dinner held by the Kokomo Post, Kokomo, Ind., of which he is a member.

Aviation Experts Confer on Atlantic Route

Aviation experts from Federal organizations and air lines attended a conference at Dublin, Ireland, to determine standard operating procedures for North Atlantic air services. Two of the principal purposes of the conference were to review and plan for the operation of the facilities necessary for air service along the North Atlantic route and to agree on the necessary operating instructions as they are required to supplement the standards set up by the Provisional International Civil Aviation Organization.

Institute members who were official delegates are: John C. Leslie, Vice-President of Transatlantic Operations, Pan American World Airways System; Delbert M. Little, Principal Meteorologist in Charge of Station Operations Division, U.S. Weather Bureau; and Delos W. Rentzel, President of Aeronautical Radio, Inc. Members of the Institute who acted as technical observers are: Frederick A. Berry, Captain, U.S. Navy; George A. Doole, Assistant Chief Pilot in Charge of Personnel, Pan American World Airways System; and James H. Smith, Assistant Vice-President, Pan American World Airways System.

Institute Members Receive Awards

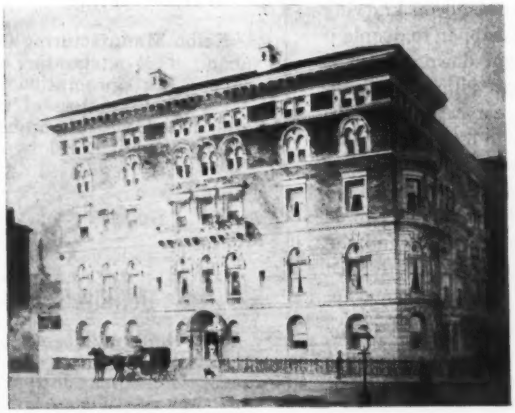
Fred E. Weick, Vice-President in Charge of Engineering, the Engineering and Research Corporation, and a Fellow of the Institute, has been presented the 1945 Fawcett Aviation Award. Presentation of the award and $1,000 was made on the "We, the People" radio program of February 17 by Capt. Edward V. Rickenbacker, President of Eastern Airlines, Inc. Given annually by Fawcett Publications, Inc., the award was presented to Mr. Weick for his contribution to the development of the dual-control, nonspinning airplane.

Mr. Weick had previously been given, by the Institute, The Sylvanus Albert Reed Award for 1944 for this work.

Honor awards also were presented to the following Institute members: Donald W. Douglas, President, Douglas Aircraft Company, Inc.; Hall L. Hibbard, Vice-President and Chief Engineer, Lockheed Aircraft Corporation; and Robert A. Lovett, formerly Assistant Secretary of War for Air.

Gifts to the Aeronautical Archives

Among the donors of gifts this month were several who have been generous to the Archives on previous occasions. Alfred Marchev sent, among several gifts, *Notes on Giant Aeroplanes*, by José Weiss and Alexander Keith, published privately at Houghton, Sussex, England, in May, 1916. Captain Walter S. Diehl, U.S.N., gave a bound volume of the *Annual Reports* of the



An architect's drawing of the New York Building of the Institute, made after its completion in 1896. A complete description of the building will appear in the May issue of the *Aeronautical Engineering Review*.

HANGAR FLYING

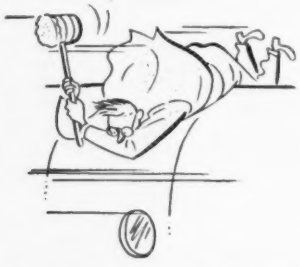
LOCKHEED

The Busted Window at 20,000

Kicking windows out of airliners isn't what you'd call approved airborne etiquette. But, not so long ago, Lockheed did just that during flight tests on the *Constellation's* Normalair cabin.

Back in the days when Wiley Post was making his pioneering swipes at the stratosphere, Lockheed engineers, of course, had learned a lot about supercharging cabins doing groundwork (and airwork) on the old Lockheed XC-35, the first plane with a fully pressurized cabin.

From the knowledge thus gained about stressing, sealing and supercharging, the research men then perfected the famous Normalair cabin. Now, while the *Constellation* sleeks along at 20,000 feet, the altitude inside the ship is a mere 8,000.



Lockheed insisted on knowing what would happen to people if pressure went down (which is unlikely, since either of two superchargers can carry the load). So one day, in a carefully planned experiment, they kicked out a window at 20,000, with 44 random-picked, ordinary people aboard. The pressure and the plane descended smoothly, and no serious discomfort turned up.

Q. E. D. If an unknown factor crops up at Lockheed, it doesn't stay unknown long. This kind of efficient curiosity makes for good planes and good hangar flying.

L to L for L

©1946, Lockheed Aircraft Corp., Burbank, Calif.

Aeronautical Society of Great Britain, from 1866 to 1873. John P. V. Heinmuller added an album of foreign pioneer flight covers to the air-mail covers he had previously given. The album includes covers from Albania, Austria, Czechoslovakia, and other countries. Dr. Alexander Klemin and Mrs. Bella C. Landauer added books and pamphlets to their previous generous gifts. Books and 47 publications of the National Advisory Committee for Aeronautics were received from Van Wyck Hewlett.

Documents relating to proceedings before the Civil Aeronautics Board regarding new air routes and extensions of existing routes were received from Eastern Air Lines, Inc.; Pan American Airways, Inc.; Transcontinental & Western Air, Inc.; and United Air Lines, Inc.

Additional gifts were received from Frank Ross, Jr.; National Association of Manufacturers; Pan American Union; Syracuse University; U.S. Army Air Forces; Senate Committee on Naval Affairs; and the Surplus Property Administration.

Corporate Members Expand

Atlas Supply Company, a Corporate Member of the Institute, has inaugurated the sale of aircraft accessories at airports, paralleling its sale of automobile accessories at service stations, throughout the United States. Colonel E. E. Aldrin, the company's Aviation Manager and a Fellow of the Institute, is in charge of the project.

Consolidated Vultee Aircraft Corporation has purchased the controlling interest in the ACF-Brill Motors Company and its wholly owned subsidiary, Hall-Scott Motor Car Company, manufacturers of motor buses, trolley coaches, and specialized engines. The transaction involved approximately $7,500,000.

Harry Woodhead, President, and I. M. Laddon, Vice-President, of Consolidated Vultee Aircraft Corporation, have been elected to the Board of Directors of the Hall-Scott company.

Eaton Manufacturing Company has acquired all outstanding shares of the Dynamatic Corporation of Kenosha, Wis., manufacturers of eddy-current and induction-drive apparatus. The devices manufacturd by the Dynamatic Corporation are based on patented eddy-current principles. Outstanding among its developments are the 18,000-hp. drive for the Boeing wind tunnel in Seattle and the 7,000-hp. drive for the Pratt & Whitney wind tunnel in East Hartford. Additional applications include electronic speed controls, dynamometers, and other equipment for testing engines, including jet-propulsion devices, electric couplings, refrigeration and air-conditioning drives, oil-well drilling equipment, brakes, punch press and other machine-tool drives, take-up reels, industrial and marine transmissions, and drives for electric shovels and hoists.

This acquisition combines the activities of the Dynamatic Corporation with those of the Eaton Research Laboratories, which have been engaged in development work on the eddy-current drives since 1940.

The B. F. Goodrich Company has purchased the Airplane Wheel and Brake Division of Hayes Industries, Inc., of Jackson, Mich. Both the Goodrich and Hayes companies are Corporate Members of the Institute.

The expander-tube airplane brake, introduced by B. F. Goodrich in 1937, has since been manufactured under license by the Hayes company. For the present, wheel and brake manufacturing operations will be continued in Jackson, Mich.

In acquiring this division of the Hayes company, B. F. Goodrich will now supply complete tire, tube, wheel, and brake assemblies to the aircraft industry.

Jack & Heintz, Inc., has entered into a merger with the Precision Products Corporation, the resulting organization to be known as Jack & Heintz Precision Industries, Inc. The new company will continue the production of airplane starters, generators, and other aircraft products and will add initially fractional horsepower electric motors, ball and roller bearings, electronic gages and precision machine tools.

The merger is the initial step in a program to broaden the scope of operations to include manufacturing and sales of equipment for the automobile, for refrigeration and air-conditioning industries, as well as for the aircraft industry.

Sections and Branches

Buffalo Section

On February 21 a meeting was held at the Buffalo Trap and Field Club, under the chairmanship of Benson Hamlin. Mr. Hamlin appointed Allen F. Donovan Acting Chairman of the Meetings and Papers Committee. Robert M. Stanley, Chief Engineer of Bell Aircraft Corporation, spoke on the subject of "Radio Controlled Flight Testing of Fighter Aircraft."

Mr. Stanley pointed out that the motivation for the development of radio-controlled flight was primarily the necessity for conducting hazardous flight tests, requiring extensive data, without risking human life. Among such tests are dive and compressibility investigations, which, in view of the

high performance attained by modern fighter-type aircraft, have led to dangerous operations in hitherto unexplored fields. Other uses of radio control include target practice, demonstration of fire hazard involved in damaged fuel bags, and intentional crash studies. For the original development, two P-59's were chosen, chiefly because of their embodying twin-engined performance, good handling characteristics, tricycle landing gear, and balanced propeller torque.

The speaker gave a comprehensive description of the automatic pilots, both displacement and rate type, including the details of the development of the rate type, which explained how the aircraft could be maneuvered in abnormal attitudes without tumbling the gyros. An electrical system for control and functional operation was used throughout. The use of both television and telemetering in connection with the procurement of data was explained. Telemetering transmits information obtained by resistance-type strain gages to a receiver on the ground at the rate of 1,000 signals per second per channel. Fourteen out of 18 channels were actually used, the data from which were recorded in an ordinary oscillograph. Mr. Stanley elaborated on the flight-training program and actual pilot technique employed during take-offs, landings, and dive testing, which ultimately came to be developed. He also enumerated the great number of safety devices that were considered necessary, particularly at the outset of the investigation.

Detroit Section

Chairman Arthur A. Locke presided over a meeting held on February 14 in the Horace H. Rackham Educational Memorial Building. Secretary R. F. Ternes read an announcement concerning a class to be held to prepare engineers for the state examination for registered engineers. Frederick W. Ross, Chief of Aerodynamics and Flight Tests in the Experimental Engineering Division of Bendix Aviation Corporation, talked on the subject "What the Personal Aircraft Should Include."

New York Section

On February 14 a meeting was held in the McGraw-Hill Building under the chairmanship of Jerome Lederer. The principal speaker was Dr. Stephen J. Zand, Senior Project Engineer of the Sperry Gyroscope Company, Inc., whose subject was "The Strategic Bombing of Germany." Dr. Zand spent 17 months in the European Theater of Operations, attached to the offices of the Director of Technical Services, U.S. Air Force Service Command.

Dr. Zand presented statistics to show the results achieved through strategic bombing and illustrated the talk with slides that gave a graphic picture of the degree of success attained. Figures were presented to illustrate the British and American aircraft losses as compared with the German, the relationship between our dwindling losses and the impotence of the Luftwaffe in the last stages of the war, and other basic factors contributing to the success of the bombing. Dr. Zand also exhibited graphs showing that German aircraft acceptances were almost continually behind schedule.

Recounting the difficulties encountered in conducting so complete an investigation, Dr. Zand stated that a great many of the records were destroyed by both sides and that intensive research and interrogation had to be employed in reaching conclusions in the survey.

Philadelphia Section

Dr. Michael Watter of the Advisory Committee presided over a meeting of the Philadelphia Section held on February 26 at the Engineers' Club of Philadelphia. John S. Kean, Chairman of the Nominations Committee, presented a slate of nominations for election to office. Elections will take place at the next meeting.

Captain Ralph S. Barnaby, U.S.N., Commanding Officer of the Naval Air Modification Unit at Johnsville, Pa., presented a paper titled "Aviation on the End of a String." Captain Barnaby holds glider pilot license No. 1 in the United States, was the first man to be launched from a dirigible in a glider, and conducted the first tow of a powered aircraft. His paper dealt with the history of gliding and towed flight and the specific problem of the air trailer. He discussed the techniques of flying air trailers, with emphasis on the use of spoilers to change the angle of glide path without change of altitude or material change in air speed. He outlined the arguments in favor of high- and low-position tow with respect to the tug airplane and the use of the special automatic pilot for the air trailer.

Captain Barnaby reviewed "snatch pickups" and the history and development of the towing of powered airplanes that have been rendered powerless by accident. He exhibited two color films showing towed flight of modern air trailers, incapacitated airplanes and glider trains, and snatch pickup demonstrations.

At the next meeting, Seymour Gottlieb, of the Naval Air Experimental Station, U.S. Naval Air Base, Philadelphia, will present a paper on "Static Test Techniques."

San Diego Section

On November 23 a meeting was held at the U.S. Grant Hotel under the chairmanship of Jack Mason. The principal speaker was Dr. H. F. Helmholz, Jr., who spoke on the subject "Aero-Medical Factors in Aircraft Design." Dr. Helmholz is well known to aviation personnel in the San Diego area because of his work as Flight Physiologist for Consolidated Vultee Aircraft Corporation and with the Aero-Medical Unit of the Mayo Clinic at Rochester, Minn.

The speaker reviewed the introduction of medicine into aviation, emphasizing the development of aero-medicine from its initial success in the protection of the health and lives of pilots to the protection of the entire flight personnel. He stressed the importance of close association between the aircraft engineer and the aero-medical man in order that problems connected with safe flying may be met and solved intelligently. Following his address, Dr. Helmholz exhibited a motion picture titled *Radial G's*, which graphically demonstrated the effects on flight personnel of radial forces that may be encountered in such flying maneuvers as spins and loops. The film was made in technicolor by the Aero-Medical Division of the Army Air Forces at Wright Field.

A dinner meeting held on March 1 at the San Diego Club was attended by 140 members and guests. Section Chairman Jack Mason summarized the recent activities of the Executive Committee and stated that the plans for the Section building had been completed and that the Executive Committee was awaiting the completion of negotiations between Consolidated Vultee Aircraft Corporation and the U.S. Navy which would result in the Section's obtaining a clear title to the building site. The Chairman then announced to the membership that Ernest G. Stout, Design Specialist in Charge of Hydrodynamics, Consolidated Vultee Aircraft Corporation, had recently been elected as one of the members of the Council for the Western Area.

Robert Johnston, Chairman of the meeting, then introduced B. T. Salmon, Chief Engineer of the Ryan Aeronautical Company, who spoke on "Composite Powered Airplanes." Mr. Salmon discussed the application of jet engines in combination with propeller-drive engines in airplanes. He approached the subject from the standpoint of performance, basing his material on the experience gained in meeting the design problems of the Ryan Fireball, FR-1, Navy Fighter. The possibilities of applying the composite power plant to classes of airplanes other than fighters, with specific reference to the potential performance gains which can be realized, were explored. A motion picture of the Ryan Fireball was shown.

Seattle Section

On February 14 the Seattle Section held a dinner meeting in the Chamber of Commerce Building. The principal speaker was Amos L. Wood, Chief, Accident and Operational Analysis Section, Engineering Division, Boeing Aircraft Company, whose subject was "Aircraft Accidents." Mr. Wood reviewed the B-17 and B-29 accidents in the light of design improvements. Lantern slides of accidents were shown.

At a meeting held on March 12, Dan Hage, of the Special Development Group of Boeing Aircraft Company, spoke on the subject "Gas Turbines and Jet Propulsion."

Academy of Aeronautics

At an election meeting held on February 18, presided over by retiring Chairman Thomas Knust, the following new officers were elected: Edward Siekierski, Chairman; Nelson Bellesheim, Vice-Chairman; Steve Zavali, Treasurer; Marvin Glenn, Secretary; Daniel McElwain and Seymour Muller, Corresponding Secretaries.

Alabama Polytechnic Institute

This Student Branch has been reactivated and the first meeting was held on February 7. John F. Keown, Acting Chairman, described the purposes and functions of the Institute.

An organization meeting was held on February 14, and the following officers were elected: Chairman, John F. Keown; Vice-Chairman, Evan F. Slider; Secretary, Huel C. McLemore; Treasurer, Robert H. Harris; Representatives, Dorothy Eloise Bridges, Robert P. Howell, William E. Lakeman, Robert Dobbins, and James N. Mueller. The Representatives will serve as a Program and Publicity Committee. Professor Robert G. Pitts, Head of the Aeronautics Department, is Faculty Adviser. Professor M. O. Williams, also of the Aeronautics Department, expressed congratulations to the members upon the reactivation of the Branch.

At a meeting held on February 28, Professor Pitts spoke on the subject "The Graduating Student's Chances of Employment." He discussed many of the possibilities that are now open for good students in the aviation field.

The Catholic University of America

Chairman Michael J. Quirk presided over a meeting held on February 19, at which Edward Gaylos, Flight Engineer with the Civil Aeronautics Administration, talked on "Flight Tests of the Lockheed Constellation." During the war Mr. Gaylos was engaged in the sifting of patents of military value which came before the C.A.A. He discussed the performance requirements and methods of the C.A.A. and how they were applied to the Constellation.

University of Cincinnati

On February 6 a meeting held in Baldwin Hall was presided over by Dean Lane. The film *PT-19* was shown.

At a meeting held on February 13, the film *Construction of the AT-21* was presented.

University of Colorado

On January 9 a combined technical and business meeting was held, presided over by Charles R. Walker, Jr. Professor K. D. Wood spoke to the group on the functions and advantages of the Institute. After a discussion it was decided that a drive be organized to increase membership. The films *Unseen Worlds* and *Winter Wonderland* were shown.

At a meeting held on February 13, the following officers were elected: William B. Moore, Chairman; John Kelly, Vice-Chairman; and Joseph C. Wilson, Secretary-Treasurer. The winner of the Branch Scholarship Award was Charles R. Walker.

Professor Philip F. Moore is Acting Faculty Adviser of the Branch, replacing Prof. K. D. Wood, who is on leave of absence until June 15.

Georgia School of Technology

The Branch award winners at the Georgia School of Technology were Thomas L. Harmon, Jr., for his paper "The Mathematical Derivation of Airfoils" and John W. Fitzpatrick, for the highest average in aeronautical subjects. A third award, made at the suggestion of the students and based on a selection of good grade average and extracurricular activities, was won by John K. Wimpress.

Iowa State College

At a technical meeting held on February 7, presided over by Robert Johnson, the films *Fundamental Nature of Air Flows and Air-Flow Separation* and *NACA Free-Spinning Wind Tunnel* were shown. Wilbur C. Nelson is Faculty Adviser.

Massachusetts Institute of Technology

An election meeting held on February 8 was presided over by the retiring Chairman, Bernard J. Haverback. Reports were given on the term's activities by the Secretary-Treasurer, Herbert E. Jacques, and the Program Director, Alfred A. Little. The following new officers were elected: Melvin B. Zisfein, Chairman; Howard A. Zwemer, Vice-Chairman; John L. Norton, Secretary-Treasurer; and A. Ralph Krenkel, Program Director.

University of Oklahoma

At a meeting held on February 13, the following officers were elected: Don Malvern, Chairman; O. D. Bradley, Vice-Chairman; and Alvin Petrik, Secretary-Treasurer. The films *Aerodynamics of Air Flow* and *Randolph Air Field* were shown. Retiring Chairman Tom M. Gale presided.

Rensselaer Polytechnic Institute

At a meeting held on February 8, the retiring Chairman, Hal DeGroff, turned over the chairmanship of the Branch to Arthur Ahlin. Professor A. J. Fairbanks spoke on the subject "What's New in Aviation." He gave a brief history of the Institute and explained the procedure followed in presenting papers at the technical meetings. He then gave a report on the highlights of the papers presented at the Fourteenth Annual Meeting in New York.

Agricultural and Mechanical College of Texas

At a meeting held on January 8, Chairman James R. Vaughan spoke to the group about membership in the Institute. The film *Building and Processing of the Fairchild AT-21* was shown.

Professor Robert M. Pinkerton, Faculty Adviser, spoke on the subject "Future Prospects for Aeronautical Engineers" at a meeting held on January 22. The film *The Flying of the Consolidated B-24* was presented.

University of Tulsa

At a meeting held on February 14 in the Phillips Engineering Building, the films *Lightning P-38* and *Streamlined* were shown, after which there was a discussion of the aeronautics exhibit for the University of Tulsa Engineers Open House. Chairman Adolf E. Kowalski presided.

Virginia Polytechnic Institute

At a meeting held on February 11, the films *Extraction of Aluminum from the Ore* and *Aluminum Fabrication Processes* (by U.S. Bureau of Mines) were shown.

A meeting held on February 25 was devoted to a discussion of the proposed Wright Field inspection trip. Chairman Fred B. Sutton presided.

News of Members

Robert E. Abbott is now a student at the Newark College of Engineering.

Stanley M. Acton has joined the faculty of Tri-State College as a Professor.

Lilburn S. Barksdale has become Vice-President of the Saval Company.

Wellwood E. Beall, formerly Vice-President in Charge of Engineering at Boeing Aircraft Company, has been appointed to the new office of Vice-President in Charge of Engineering and Sales.

Lawrence Berko is now a Stress and Vibrations Engineer at Wright Aeronautical Corporation.

Victor E. Bertrandias has been elected a Vice-President of the Douglas Aircraft Company, Inc. In addition, he has been appointed Director of Foreign Sales.

Henry D. Block is now an Aerodynamicist with the Fairchild Engine and Airplane Corporation.

William Bollay has returned from active duty as a Lieutenant Commander with the Bureau of Aeronautics, Navy Department, to become Head of the Technical Research Laboratory, North American Aviation, Inc.

Felix Chardon is now an Engineer with Republic Aviation Corporation.

Robert C. Clark has joined Commonwealth Aircraft, Inc., as Structural Engineer.

Mark H. Clarkson is now a Research Engineer at the Defense Research Laboratory of the University of Texas.

David M. Classen has joined the Ranger-Lark Division of Fairchild Engine and Airplane Corporation as Weight Engineer.

Harold W. Davis is now a Project Engineer at Kellett Aircraft Corporation.

Carlos A. de Medeiros is a Structures Engineer at Aeronca Aircraft Corporation.

John L. Drew has become a Partner in the firm of Drew & Peters.

Walter A. Dunes has joined the Apex Electrical Manufacturing Company as Design Engineer.

Bernard Engel is now Chief of Aerodynamics at Teicher Manufacturing Company.

Ralph H. Eshelman has joined Reo Motors, Inc., as Minor Layout Man—Body Engineering.

Frederick F. Fennema is now Assistant Chief Operational Engineer at American Airlines, Inc.

Harry Fiedler has joined Goodyear Aircraft Corporation as Stress Engineer.

Edward E. Foster has become Head of the Technical Engineering Department at Columbia Aircraft Corporation.

Charles B. Francis is now a Junior Aerodynamicist at The Glenn L. Martin Company.

Artemus L. Gates, former Under-Secretary of the Navy, has been presented the Distinguished Service Medal by James Forrestal, Secretary of the Navy.

Karl P. Grube has been appointed Director of Contract Requirements at Douglas Aircraft Company, Inc.

Burt J. Hall is now a Layout Designer at The Glenn L. Martin Company.

George L. Haller has joined the faculty of The Pennsylvania State College as Assistant Dean of the School of Chemistry and Physics.

Fred Heddleson has become Sales Manager of A. C. Weierich Company.

Jerome Hoffer, Jr., is now Manager of Woodward Airport and Manager of Hoffer's Flying Service.

Claude R. Howard has joined Cessna Aircraft Company as Structural Engineer.

John R. Howard is an Aerodynamicist at North American Aviation, Inc.

Jerome C. Hunsaker, Chairman of the National Advisory Committee for Aeronautics, and Head of the Departments of Mechanical and Aeronautical Engineering at Massachusetts Institute of Technology, has been elected a Director of the Sperry Corporation and its subsidiaries.

Charles H. Hurkamp, Jr., has joined McDonnell Aircraft Corporation as Project Engineer.

Carl D. Kolbe is now a Strength Test Engineer at Douglas Aircraft Company, Inc.

Ralph C. Lenz, Jr., now in the U.S. Army Air Forces, is currently assigned to the Flight Design Data Unit, Air Technical Service Command, Wright Field, as an Aeronautical Engineering Technical Aide.

Willy Ley has become a Research Engineer at the Washington Institute of Technology.

Albert I. Lodwick has become President and Managing Partner of the Lodwick School of Aeronautics, Inc.

Lionel London is now a Structural Designer with the firm of Holabird & Root.

Guy A. Luburg has become Chief of the Master Planning Department at Edo Aircraft Corporation.

Otto H. Lunde has returned from active duty as an officer with the Bureau of Aeronautics, Navy Department, to resume his post as Professor of Aeronautical Engineering at the University of Alabama.

Sidney Mayster has joined the firm of Erik Floor & Associates as Staff Engineer.

Ralph H. McClarren has become Director of the Division of Electronics and Instruments at the Franklin Institute Laboratories for Industrial Research.

Walter S. Misener is now an Aerodynamicist at Turbo Research Limited.

Robb C. Oertel has been elected a Director of the Airport Division of the American Road Builders' Association.

Paul W. O'Meara has joined the El Segundo Division of Douglas Aircraft Company, Inc., as a Designer.

Wayne W. Parrish has been elected a Director of the Airport Division of the American Road Builders' Association.

Millard F. Perry is now an Engineer in the Automatic Pilot Laboratory in the Engineering Department of the Eclipse-Pioneer Division of Bendix Aviation Corporation.

David C. Prince has been awarded the 1945 Lamme Medal of the American Institute of Electrical Engineers "for his distinguished work in the development of high voltage switching equipment and electronic converters."

Richard F. Puck has joined the Autoflight Instruments Division of G. M. Giannini & Company.

Norman Rafel is now a Structural Engineer with the Ranger-Lark Division of Fairchild Engine and Airplane Corporation.

Charles B. Ripley has left the U.S. Army Air Forces and returned to the Engineering Staff of Aero Insurance Underwriters.

James M. Robertson has returned to the faculty of The Pennsylvania State College as Assistant Professor of Engineering Mechanics.

Frederick H. Roever is now Chief Instructor at the Riddle Aviation School.

Leonard E. Root, Chief Aerodynamicist at the El Segundo Plant of Douglas Aircraft Company, Inc., has been selected by the United States Junior Chamber of Commerce as one of the nation's ten outstanding young men of 1945 for his achievements in the field of aerodynamics.

Irvine E. Ross is now Assistant Chief Engineer at Victor Electric Products, Inc.

Leslie J. Ross has become President of the Aeronautical Company.

Thomas B. Salter has been elected a Director and Vice-President of the Cessna Aircraft Company.

Jerome M. Schwarzbach has joined the Ranger-Lark Division of Fairchild Engine and Airplane Corporation as an Aerodynamicist.

Robert L. Seebol is now a Design Engineer at Warren McArthur Corporation.

Francis P. Somers has become Chief Chemist of the Airborne Equipment Division, Bureau of Aeronautics, Navy Department.

Wieslaw Z. Stepniewski is now Chief Aerodynamicist at Jet Helicopter, Reg'd.

Wesley A. Steyer has joined Northrop Aircraft, Inc., as a Designer.

Edward L. Stickel is now a Junior Engineer in the International Division of Trans-World Airlines.

Joseph W. Stout has been appointed a District General Manager of Pennsylvania-Central Airlines Corporation.

Albert H. Streicher is now a student at Purdue University.

John T. Strickland has joined the Ranger-Lark Division of Fairchild Engine and Airplane Corporation as Senior Flight Test Engineer.

Clarence M. Tyler, Jr., is now a Graduate Assistant in the Aeronautical Engineering Department of the University of Pittsburgh.

Kurt Wagenknecht has joined Transcontinental & Western Air, Inc., as Senior Production Control Engineer.

William K. Warner is now Chief Engineer of the Appliance Division of Hydro-Aire.

Edwin A. Warren has joined Slick Airways, Inc., as Vice-President of Operations.

Clifford M. Webb is now a Tool Designer at Richards Wilcox Canadian Company, Limited.

Charles B. West has joined Beech Aircraft Corporation as an Aerodynamicist.

John B. Wheatley has become Senior Project Engineer at the Allison Division of General Motors Corporation.

Harvey L. Williams has been elected Executive Vice-President of Chicago and Southern Airlines, Inc.

Reginald H. Wilson has joined the Executive Staff of the Cambridge Instrument Company.

William S. Woodward has joined Edo Aircraft Corporation as Assistant Project Engineer.

Fred T. Yee is now an Associate Engineer at Gibbs and Hill, Inc.

Paul C. Zmola has joined the Faculty of Purdue University as an Instructor in Mechanical Engineering.

Members Elected

The following applicants for membership or applicants for change of previous grades have been admitted since the publication of the list in the last issue of the REVIEW.

Transferred to Associate Fellow Grade

Bittner, Raymond Albert, B.S. in Ae.E.; Production Supervisor, War Dept. (Wright Field).

Salmon, Benjamin Tyler, Chief Engineer, Ryan Aeronautical Co.

Elected to MEMBER Grade

Clayton, William Keller, C.E.; Chief Inspector, Platt-LePage Aircraft Co.

Deters, Owen John, B.Sc.; Associate Aeronautical Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Gilmore, Arthur Warham, B.Ae.E.; Jr. Product Engineer, Sperry Gyroscope Co., Inc.

Johnson, Arlo Franklin, B.S. in Ae.E.; Asst. Prof. of Aeronautical Engineering, University of Illinois.

Transferred to MEMBER Grade

Davis, Samuel, M.Sc.; Consultant.

Wegmann, John, Jr., Engineering Designer, Ryan Aeronautical Co.

Elected to Technical Member Grade

Chauvin, Leo Theobald, B.Sc.; Aeronautical Engineer, Langley Mem. Aero. Lab., N.A.C.A.

Pierpoint, Thomas Reynolds, Helicopter Flight Test Engineer, P-V Engineering Forum.

Yang, Ru-Chi, B.S.; 1st Lt., Aeronautical Engineer, Chinese Air Force.

Transferred from Student to Technical Member

Connelly, John Joseph, Jr., B.Ae.E.; Ensign, U.S. Navy.

Cowen, Arnold, B.S. in Ae.E.; Design & Layout Man, Republic Aviation Corp.

Goodman, Theodore R., Student, California Institute of Technology.

Haight, Bruce Rodney, B.S.; Ensign, U.S. Navy.

Harmon, Thomas Leonhardt, Jr., B.Ae.E.; Ensign, U.S. Navy.

Mellen, David Lyle, B.S. in Ae.E.; Ensign, U.S. Navy.

O'Brien, Edward Hawkes, B.Ae.E.; Asst.—Aero. Wing Flutter Group, Massachusetts Institute of Technology.

Simpson, James Fenton, Jr., B.Ae.E.; Layout Engineer, Beech Aircraft Corp.

Yip, Roy Wing, B.S. in Ae.E.; Engineer and Designer, Arrow Plastics, Ltd. (Canada).

Necrology

Frederick William Lanchester

Frederick William Lanchester, Consulting Engineer and a Fellow of the Institute, died at his home in Birmingham, England, on March 8.

Born at Lewisham, England, on October 23, 1868, Dr. Lanchester studied at the Royal College of Science and the Finsbury Technical College. In 1920, the University of Birmingham conferred on him the honorary degree of Doctor of Law.

From 1889 to 1892 he was Designer and Assistant Works Manager of the Forward Gas Engine Company, specializing in internal-combustion engines. He then developed the Lanchester car and in 1899 formed the Lanchester Motor Company, Limited, serving as General Manager and Chief Engineer. From 1904 to 1914 he was Consulting Engineer to that company and to Daimler Company, Limited. He was Consultant and Technical Adviser to the Birmingham Small Arms Company, Limited, from 1909 to 1929. He became a member of the British Advisory Committee for Aeronautics in 1909, which post he retained until 1920. In 1928, he became a Consultant to William Beardmore and Sons, Limited, a Diesel engine works.

Dr. Lanchester made numerous successful inventions relating to the internal-combustion engine, including the gas-engine starter in 1890, the balanced reciprocating engine and the surface carburetor in 1895, the torsional crankshaft damper in 1910, and the harmonic balancer in 1911. Among his published works are *Theory of Stability, Aerial Flight, Aircraft in Warfare, Flying Machine from an Engineering Standpoint, The Theory of Sustentation and Expenditure of Power in Flight,* and *A Contribution to the Theory of Propulsion and the Screw Propeller.*

An Honorary Fellow of The Royal Aeronautical Society, Dr. Lanchester received the Society's Gold Medal and delivered the Wilbur Wright Memorial Lecture before The Royal Aeronautical Society in 1926. In 1931, he was awarded The Daniel Guggenheim Gold Medal.

Personnel Opportunities

This column is for the use of individual members of the Institute seeking new connections and organizations offering employment to aeronautical specialists. Any member or organization may have requirements listed without charge by writing to the Secretary of the Institute.

WANTED

Aeronautical Engineers—The U.S. Naval Air Station, Quonset Point, R.I., is accepting applications of highly qualified aeronautical engineers for future positions. Salary range from $2,320 to $5,180 per annum. Applicants may obtain Civil Service Application Form 57 from local post office. Forward applications, completely filled out, to the Recorder, Labor Board, U.S. Naval Air Station, Quonset Point, R.I.

Instructor in Aeronautical Engineering—To teach courses in general aeronautics and stress sections. Must have aeronautical engineering degree. Opportunity to do graduate work. Appointment for September 15, 1946. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Assistant or Associate Professor—To conduct senior and graduate courses in airplane stress and design group. Must have M.S. degree in Aeronautical Engineering and experience in industry or teaching. Appointment for September 15, 1946. Salary open. Address: Department of Aeronautical Engineering, University of Minnesota, Minneapolis, Minn.

Detail and Layout Engineers and Stress Analysts—For development work and production engineering work in Engineering Division. Write for application blank to Chief Administrative Engineer, Boeing Airplane Company, Wichita, Kan.

Aerodynamicists—College graduates with sound theoretical training and at least 1 year of graduate study in compressible subsonic flow and supersonic flow to do research and test work in the Supersonic Wind Tunnel of the Ballistic Research Laboratories, Aberdeen Proving Ground, Maryland. This is by far the largest operating supersonic wind tunnel in the country. Remuneration in accordance with qualifications. Write, giving education and experience, to The Commanding General, Aberdeen Proving Ground, Maryland, Attention: Director, Ballistic Research Laboratories.

Technical Representatives—To perform industrial representation within their resident state, county, or city for manufacturers and associated concerns throughout the country. Must have permanent position with an es-

tablished company and complete domestic and technical information. Address inquiries to George E. Harris Associates, Rooms 314–318, Administrative Building, Municipal Airport, Wichita, Kan., Attention: G. E. Harris.

Design Engineers, Stress Analysts, Layout and Draftsmen—Needed for development work on experimental military aircraft, as well as production engineering. Address inquiries to Curtiss-Wright Corporation, Airplane Division, Columbus 16, Ohio, Attention: R. C. Blaylock, Chief Engineer.

Research Engineer—Theoretical Aerodynamicist or Thermodynamicist with advanced degree to engage in research on certain high-speed developments. For details write Box 1-T, Richmond 2, Va.

Design Engineers; Draftsmen—Opportunities now exist for qualified design engineers and draftsmen for work on the new stratocruiser C-97 military transport and other new developments. Here is an opportunity to become associated with one of the world's leaders in aircraft design and production and to participate in the design of the aircraft of tomorrow. Write to the Engineering Department, Boeing Aircraft Company, Seattle 14, Wash.

Aerodynamicists and Thermodynamicists—Research minded and with good theoretical background, to engage in research work on high-speed and jet propulsion developments, advanced degrees preferred. Salary commensurate to qualifications. Replies will be held in strict confidence. Write, giving education and experience, to Cornell Aeronautical Laboratory, Buffalo 5, N.Y.

Aeronautical Engineering Professor to teach Airplane Design, Airplane Structure, and related subjects. Applicants required to have a degree in aeronautical engineering as well as practical experience in the field. Preference given to candidates having advanced degrees. Facilities now under construction and plans for future construction will provide ample opportunity for research, development, and consultation. Rank and salary will depend upon training and experience of applicant. In applying please give brief sketch of personal qualifications, education, and experience. Address reply to Prof. Robert M. Pinkerton, Department of Aeronautical Engineering, A. & M. College of Texas, College Station, Texas.

Aircraft Engineers—Immediate, permanent openings for aircraft engineers with 5 years' experience in aerodynamics, structural design, and C.A.A. airworthiness requirements with Southern California aircraft manufacturer. Air-mail qualifications and recent photo to P.O. Box 29, Burbank, Calif.

Radio, Electronic and Telephone Engineers, Electronic and Mechanical Draftsmen—One of the largest manufacturers of a wide variety of electronic and communications equipment in the world is fully prepared and ready with an ambitious postwar program. Write to Personnel Manager, Federal Telephone & Radio Corp., 591 Broad Street, Newark, N.J.

Aeronautical Engineer—To teach Senior year subjects of aeronautical engineering course including design and stress analysis. Address inquiries to The Aeronautical University, Inc., 116 South Michigan Avenue, Chicago, Ill.

Aircraft Stress Engineers thoroughly familiar with the analysis of aircraft structures, aircraft controls, and all component parts for work on helicopters. Excellent opportunities for personnel interested in rotary-wing aircraft. Apply by letter, giving references, to Administrative Engineer, Kellett Aircraft Corporation, Plant #2, Lansdowne Avenue above State Road, Upper Darby, Pa.

Personnel Needed—Executive and Administrative experience in manufacture of aircraft. Positions available in several fields: Factory and Production Management, Matériel, Tooling and Engineering. McDonnell Aircraft Corporation, Ambassador Building, St. Louis 1, Mo.

Aeronautical Engineers—for immediate work, the long-established Aeronca Aircraft Corporation seeks project engineers, design engineers, weight engineers, and layout draftsmen. These positions offer unusual permanent opportunities with the pioneer light-plane company of America for qualified men. Write in complete detail to Aeronca Aircraft Corporation, Box 00, Middletown, Ohio.

Project Engineer, Chief of Structures—Excellent opportunity for qualified men with a manufacturer of medium sized aircraft. Commercial experience preferred but not necessary. Address inquiries to Box 498, Institute of the Aeronautical Sciences.

Assistant or Associate Professor—Sought by Aeronautics Department of Engineering College to teach undergraduate and graduate courses in aerodynamics, aircraft structures, or aircraft propulsion. Must have good academic training and teaching experience; constructive interest in aeronautical research and development, preferably industrial or laboratory experience in this field. Starting salary range: $3,000 to $5,000, depending upon qualifications. Address inquiries to Box 490, Institute of the Aeronautical Sciences.

Instructor—In department of mechanical engineering to teach mainly aerodynamics, aeronautical design, and develop aeronautical laboratory. Advanced degree desired. Appointment April or September as Instructor or Assistant Professor, dependent on qualifications. Location Philadelphia. Address inquiries to Box 477, Institute of the Aeronautical Sciences.

Design Draftsmen—To prepare working plans and detail drawings of new or improved products, sketching from engineering notes; checking designs for engineering accuracy; supervising some Detail Draftsmen who may be assisting. At least 5 years' experience required. Salary of $50 to $70 for 40-hour week, time and one-half for any overtime. Address inquiries to Box 476, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Prominent light-plane manufacturer located in New York area seeking qualified aeronautical engineers including aerodynamicists, stress analysts, loftsmen and draftsmen, particularly those experienced in molded plywood and sheet metal structures. Military and civil contracts. Address inquiries to Box 466, Institute of the Aeronautical Sciences.

Assistant Chief Aircraft Designer—Good background and experience in civil aircraft and conversant with C.A.A. requirements. Permanent position with aircraft manufacturer in Central Eastern Coast area. Reply by letter giving particulars as to experience, salary desired, and date available. Address inquiries to Box 463, Institute of the Aeronautical Sciences.

Chief Stressman with C.A.A. requirements experience, and **One or Two Assistants,** to take charge new project. Permanent position with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 462, Institute of the Aeronautical Sciences.

Layout and Detail Draftsmen, Senior and Junior—Required for progressive aircraft program with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience, salary required, and when free to take up a new position. Address inquiries to Box 461, Institute of the Aeronautical Sciences.

Aircraft Design Engineers—Immediate permanent openings for design engineers with good experience in aerodynamics, structural design and C.A.A. airworthiness requirements with aircraft manufacturing firm on middle eastern coast. Reply stating full particulars of past experience,

salary required, and when free to take up a new position. Address inquiries to Box 460, Institute of the Aeronautical Sciences.

Designing Draftsman—Design ignition components of electronic and electromechanical nature. Also do follow-up on experimental orders. Should be conversant with design for low-cost production. Starting salary of $70 to $85 for 40-hour week; time and one-half for any overtime. Address inquiries to Box 458, Institute of the Aeronautical Sciences.

Assistant Engineer—Design work, test work, test analysis, and creative development work in high-frequency ignition and electrical test equipment program. Must have experience in modern electronic design, test and development methods. Starting salary of $4,200 to $4,800. Address inquiries to Box 456, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Immediate positions open in Washington, D.C., for aircraft engineers with practical experience in structural design and research. Salary between $3,640–$5,180 per year. In applying please give brief sketch of personal qualifications, education, and experience. Address inquiries to Box 448, Institute of the Aeronautical Sciences.

Stress Analyst—Engineer with experience in design of rotary wing aircraft rotor blades. Must have thorough knowledge of rotor blade stress and aerodynamic analysis procedure, experimental procedure for determination of static and dynamic stresses and fatigue research methods. Permanent position involving study of wood, metal, and plastic blades. Address inquiries to Box 443, Institute of the Aeronautical Sciences.

Assistant Professor of Aeronautical Engineering—Must have experience in structural analysis and design. Permanent position. Applicants should furnish details describing education, experience, and personal data. College located in Virginia. Address inquiries to Box 442, Institute of the Aeronautical Sciences.

Assistant Professor—To conduct senior and graduate courses, develop laboratory, and direct research in aircraft power plants, with emphasis on standard aircraft engines and accessories. Advanced degree preferred. Position with an established aeronautical engineering department of a large eastern university. Appointment September, 1946. Salary open. Address inquiries to Box 434, Institute of the Aeronautical Sciences.

Aircraft Layout Draftsmen—Familiar with layout and design of aircraft sheet metal structures, controls, mechanisms, power plant, electrical systems and equipment. Excellent opportunities for experienced personnel interested in helicopter design. Address inquiries to Box 414, Institute of the Aeronautical Sciences.

Assistant or Associate Professor—To conduct undergraduate and graduate work in theory, design, and research in propellers and jet and rocket propulsion systems. Applicant should have at least one graduate degree and a sound theoretic and applied background in the thermodynamics and aerodynamics of propulsion systems. Large Mid-western University. Address inquiries to Box 413, Institute of the Aeronautical Sciences.

General Manager—A medium-sized aircraft company has opening for man qualified to direct manufacturing, sales, quality, personnel, accounting, and engineering functions. Must have long experience in management and good education. Company working on Government contracts, commercial aircraft production, and other manufacturing. Address inquiries to Box 410, Institute of the Aeronautical Sciences.

Research Fellows—To work half time on industrial research programs and study half time for M.S. or Ph.D. degree. Salary $1080 for 12 months together with freedom from tuition fees. Extra compensation during summer months may be obtained by working full time. Address inquiries to Box 398, Institute of the Aeronautical Sciences.

Research Engineer—To work on industrial research program. Electrical, mechanical, or civil engineering degree and some experience in materials-testing and vibration theory desirable. Salary $2600 or more depending on experience. Address inquiries to Box 397, Institute of the Aeronautical Sciences.

Engineer of Tests—To take charge of commercial and industrial structures and materials tests. M.S. degree and laboratory experience desirable. Opportunity to work for doctorate. Salary $3000 or more for 12 months depending on experience. One month vacation with pay. Address inquiries to Box 396, Institute of the Aeronautical Sciences.

Project Engineer—Experienced and talented design man to undertake the responsibility for a new aircraft project from inception to completion. Plant located on eastern seaboard. Salary scale above average. Write full particulars. Address inquiries to Box 370, Institute of the Aeronautical Sciences.

Works Manager—Manufacturing executive to set up and operate a production program on a new aircraft. Will direct Manufacturing, Facilities, Inspection and Procurement Departments. Salary scale above average. Located on eastern seaboard. Write full particulars. Address inquiries to Box 369, Institute of the Aeronautical Sciences.

Airplane Salesmen—Large established producer of personal aircraft seeking several qualified airplane salesmen with both flying and merchandising experience. Interview in New York. Address inquiries to Box 362, Institute of the Aeronautical Sciences.

Associate Professor of Aircraft Structures—To teach senior and graduate courses in aircraft structural theory, develop structures laboratory, and direct graduate structural research work. Practical experience necessary. Advanced degrees preferred. Permanent position. Leading State University. Location—Midwest. Address inquiries to Box 340, Institute of the Aeronautical Sciences.

Associate or Full Professor: To teach advanced courses and direct research in the Aircraft Power Plant Design field. Recent experience in turbine and jet engine design and testing necessary. Advanced degrees preferred. Permanent position, large mid-western university. Can wait six months if necessary. Address inquiries to Box 339, Institute of the Aeronautical Sciences.

Assistant or Associate Professor of Aerodynamics—Young man with Ph.D. to teach graduate courses in theoretical aerodynamics and direct theoretical and experimental research in this field. Research experience necessary. Position permanent. Mid-western State University. Address inquiries to Box 338, Institute of the Aeronautical Sciences.

Associate or Professor of Aerodynamics—To teach performance, control, stability and develop correlating flight test and flight instrumentation courses for large mid-western university. Position permanent. Practical experience necessary. Advanced degrees preferred. Address inquiries to Box 337, Institute of the Aeronautical Sciences.

Patent Engineer—Familiar with patent disclosures and procedures. Essential helicopter industry. Salary commensurate with experience and present earning capacity. Address inquiries to Box 322, Institute of the Aeronautical Sciences.

Assistant Professor—To teach Mechanics, Strength of Materials, and Physics in a small Mid-western College. Must have Master of Science Degree, preferably in Engineering or Physics. Salary dependent on qualifications and experience. Position permanent. Address inquiries to Box 291, Institute of the Aeronautical Sciences.

AVAILABLE

Engineer—E.E.; Executive or Administrative. Thirty-one years old. Ten years' experience electronics, servos, aircraft and industrial controls, ignition, sales engineering. Qualified in automatic temperature and propeller pitch controls and automatic pilots. Previous positions:

head of research lab, central office engineer, assistant chief engineer, chief engineer. Capable of directing activities and handling men. Responsible position. Available immediately. Address inquiries to Box 271, Roslyn, L.I., New York.

Aeronautical Engineer-Aerodynamicist—B.S. Ae.E. Ten months' research experience testing wings, tail surfaces, propellers in wind tunnel. Six months' aircraft-engine research and development. Available immediately. New York area preferred. Address inquiries to Box 499, Institute of the Aeronautical Sciences.

Assistant Sales Manager—B.S. in M.E. Age 33; married. Ten years' aeronautical experience with two large companies. Before the war was Assistant to the Sales Vice-President of aircraft accessory firm, with extensive traveling experience. Now Major in Air Corps on terminal leave. Address inquiries to Box 497, Institute of the Aeronautical Sciences.

Aeronautical Engineer—World War II veteran; B.S. in GE with AE option from Georgia Tech. Twenty-four years old; 2 years', 8 months' experience in the development of aircraft engines (conventional and jet) and propellers in the Engineering Division, Air Technical Service Command, Wright Field. Available after June 1, 1946. Will locate anywhere. No objection to traveling. Address inquiries to Box 496, Institute of the Aeronautical Sciences.

Manufacturing Executive—Twenty years' experience in engineering and production, both United States and England. Desires connection with small concern where experience and ability can prove results. East Coast preferred. Available one month's notice. Address inquiries to Box 495, Institute of the Aeronautical Sciences.

Airline Engineer—For embryo air lines in need of financial analyses and operational and management studies. Has two aeronautical engineering degrees (working for third). Six years' aeronautical experience—air line, manufacturing, teaching. Address inquiries to Box 494, Institute of the Aeronautical Sciences.

Power-Plant Designer—Age 26, Mechanical and Aeronautical degrees. Five years' experience with power-plant installation problems including cowling and cooling, duct design, and exhaust systems. Recent experience in turbojet engine installation work, including induction systems, tail pipe, and nozzle. Excellent references. Address inquiries to Box 493, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Speaks and writes Spanish. Leaving July 15 on extensive tour of South American aircraft factories, airports, and flying schools. Can handle some additional sales survey or customer liaison work. Address inquiries to Box 492, Institute of the Aeronautical Sciences.

Aeronautical Engineer—(New Zealand). First Class Honors, B.Sc. Degree at London University. Three years' postgraduate work in mathematics. Eight and one-half years' experience in major English aircraft firm, including 2 years in workshops, 1 year in wind tunnel, 3 months in stress department, and the remainder on aerodynamics and project design, such as performance, general aerodynamics, wing section theory and design, and flutter and stability control (for which now responsible). Three years on flight-test work as observer, combined with above work. Desires responsible engineering position. Available immediately, subject to travel facilities from Great Britain. Address inquiries to Box 491, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Age 24; married. B.S. in Aeronautical Engineering. Two and one-half years' training and experience in maintenance and repair of all Navy-type aircraft and engines. Desires connection with air line or aircraft manufacturer in an engineering capacity. Address inquiries to Box 489, Institute of the Aeronautical Sciences.

Engineer—Design or Administrative—Twenty years' practical experience in aircraft design and administration with well-established firms. Design experience includes preliminary, proposal, and manufacturing phases of both fixed and rotary wing aircraft. Desires position of responsibility in either design or administration. East Coast preferred. Address inquiries to Box 488, Institute of the Aeronautical Sciences.

Engineer—Aeronautical, Sales and Personnel—Ex A.A.F. Major, recently released by Air Technical Service Command. Age 32; married. Military experience: 3 years as Engineering Officer at one of largest bomber plants, assisting contractor in handling engineering with prime designer and A.A.F.; approximately 1 year as service liaison engineer. Civilian experience: 1 year as Director of Personnel and Labor Relations for a leading aircraft accessory manufacturer; 3 years as sales engineer, and creator and organizer of that department for same company; 3½ years' diversified experience in retail sales, aircraft and allied industry production and engineering. Desires connection wherever experience can be best utilized. Excellent references. Address inquiries to Box 487, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate with 12 years' practical experience in aircraft-engine design. Familiar with engineering, development and testing of superchargers. Two years' experience as Chief Engineer in plastics plant for aircraft turrets and noses. Desires engineering position preferably supervisory. New York area preferred. Address inquiries to Box 486, Institute of the Aeronautical Sciences.

Pilot—Marine Air Corps; age 24. Commercial license with single, twin, land ratings. Partial college education in business administration. Previous practical business experience; small-scale sales experience. Desires position with aviation firm or aviation products firm in sales-contact, field representative work. Future opportunity primary consideration; salary secondary. Address inquiries to Box 485, Institute of the Aeronautical Sciences.

Aeronautical Engineer — B.S. Ae. Navigation and drafting experience in U.S. Army Air Forces. Desires position as draftsman or aerodynamicist with air line or manufacturer. Location open. Address inquiries to Box 484, Institute of the Aeronautical Sciences.

Aerodynamicist — B.Aero.E. with distinction from the University of Minnesota; age 26, married. Four full years' experience with prime Navy contractor in stability and control, compressibility, wind-tunnel test, performance, and aerodynamic design of all types of aircraft. Desires position with aircraft, business, or educational organization. Opportunities to apply knowledge and to advance are of primary interest; salary secondary. Any location considered. Available immediately. Address inquiries to Box 483, Institute of the Aeronautical Sciences.

Research Professorship—or equivalent nonindustrial research connection is desired by aircraft engineering executive, who wants to change from industrial work to fundamental research in applied physics and theoretical aerodynamics. Sc.M. in Aeronautical Engineering from Massachusetts Institute of Technology. Twenty years' experience as head of aircraft engineering department. Address inquiries to Box 482, Institute of the Aeronautical Sciences.

Helicopter Engineer—Completely familiar with helicopter design procedures and C.A.A. procedures for approval of airplanes and rotorcraft. Holds Bachelor's and Master's degrees in Aeronautical Engineering. Desires responsible position in company engaged in manufacture of helicopters. Will also consider position as Professor of Aircraft Structures and Helicopter Design at recognized University. Address inquiries to Box 481, Institute of the Aeronautical Sciences.

Physiological Psychologist—Ph.D. 1939. Ten years' research experience in the field of human engineering in aviation, including vision, visibility, cockpit illumination, exterior lighting of aircraft, instrument lighting, hearing, speech intelligibility, anoxia, fatigue, drugs, selection, crash analysis,

in-flight and preflight feeding, and passenger comfort. Formerly college instructor; at present, Officer-in-Charge, Navy Lighting Projects. Desires position with an air line to develop a program of "Test and Evaluation," preferably in Department of Engineering Research and Development. Will advise engineering staff on human engineering and will test and evaluate equipment, present and proposed, with respect to efficiency of pilot and crew and to passenger comfort. Address inquiries to Box 480, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Former Army pilot (all types) and engineering officer. Many years' experience in design, inspection, manufacture and test. Hydraulics and supercharger specialist. Broad knowledge of aerodynamics, thermodynamics, and design practice. Excellent engineering draftsman; holder of patents; many ideas for future development. Desires development work on engines or airplanes. Address inquiries to Box 478, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E. degree. Civilian experience: 1 year as aerodynamicist specializing in wind tunnel. Military experience serving with Navy as aircraft engineering officer. Age 25, married. Available in July. Desires responsible position in East or Mid-West as Aerodynamicist or Flight Test Engineer. Address inquiries to Box 475, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S.Ae.E. degree, 26 years old, World War II veteran. Six months' experience as Fuel System Design Engineer with Air Technical Service Command, U.S.-A.A.F. Over three years' experience in the U.S. Air Corps as Flight Engineer and Maintenance Chief on heavy bombardment-type aircraft. Experienced in supervising groups. Desires a permanent design or layout position with aircraft manufacturer. Any location in the United States will be considered. Address inquiries to Box 474, Institute of the Aeronautical Sciences.

Administrative Engineer—B.A.E. Seven years' experience in airplane design (preliminary and production), research, shop work, factory liaison, and salvage work. Group Leader. Airplane and helicopter experience. Available soon as assistant to busy executive in general management or engineering; aircraft or allied field. New York area preferred but not essential. Address inquiries to Box 473, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E., 14 years' flying and 12 years' engineering experience including design problems, development of test and control devices, performance studies and conduct of airplane, power plant and accessory flight-test projects, seeks product-improvement position requiring design aptitude and test ability. Interests not restricted to aircraft field provided employer can benefit from aviation background. Address inquiries to Box 471, Institute of the Aeronautical Sciences.

Aircraft Power Plant Engineer—B.S. in M.E.; 12 years' in aviation with leading aircraft and engine manufacturer. During recent years in charge projects, including personnel, involving installation, operation, maintenance, and overhaul of aircraft power-plant equipment. Qualified to assume complete management of such projects. Wide acquaintance with key personnel airlines, aircraft manufacturers, distributors, service bases, A.A.F., and Navy Bureau of Aeronautics. Travel or live anywhere. Address inquiries to Box 470, Institute of the Aeronautical Sciences.

Chief or Assistant Chief Engineer—M.I.T. graduate, age 36, extensive background in research and development work and air transport engineering. Ex-Lieutenant Colonel A.A.F. Formerly Chief Aeronautical Engineer of large foreign air transport division handling all phases of aircraft engineering, maintenance, flight test, etc. Production engineering experience with A.A.F. Matériel Command at Wright Field. Heavy prewar experience in aircraft-engine development and testing. Desires position with good future leading to executive status. Location open; available immediately. Address inquiries to Box 469, Institute of the Aeronautical Sciences.

Expert Mechanical Design Engineer—Fifteen years' internal combustion engine design experience, including 3 years on diesel engines, 6 years on aircraft engines, last 2 years on high-temperature rotating machinery including gas-turbine aircraft auxiliary power plant. Interested in design supervision, engineering liaison, or sales engineering. Address inquiries to Box 468, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Spanish-born and educated, author of English-Spanish aviation dictionary. Will undertake technical translations into European or Latin-American Spanish; books, brochures, advertising copy. Address inquiries to Box 467, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Doctor of Aeronautical Engineering desires associate or assistant professorship in aeronautical department of university. Good teaching experience in aerodynamics and aircraft structures; several years in aviation industry on airplane design. Address inquiries to Box 465, Institute of the Aeronautical Sciences.

Tool Engineer—Aircraft and machine-shop experience; desires subcontracts for tool design, processing or special machinery. Address inquiries to Box 464, Institute of the Aeronautical Sciences.

Planning and Scheduling Engineer—M.E. degree, 1940, Carnegie Institute of Technology (Aero Option). Six years of experience. One year of experience in planning and scheduling the complete airplane before design given to project. Actual job coordinated with a representative from the factory and representative from engineering production design department and himself. Three years of experience in structural design supervision. One year of experience in engineering liaison. Desires position breaking down the design, planning the component parts and scheduling, and following its progress throughout its engineering design stages. Address inquiries to Box 455, Institute of the Aeronautical Sciences.

Management Executive—Vice-president and general manager of engineering for consulting company doing war work seeks new connection. Twenty years' experience as executive in engineering, production, and general management. Specially qualified as an organizer and production consultant. Experienced major air-line executive. Address inquiries to Box 454, Institute of the Aeronautical Sciences.

Executive—Age 37, single, Protestant, English-American. Fifteen years' continuous, well-rounded aircraft experience. Has experience in ground and flight instruction; airport and seaplane base management; airplane sales (sold over 50 aircraft prewar); charter and photographic; airline; manufacturing (inspector to factory manager); C.A.A. (inspector), quality control, engineering, research, and development. Was a key man with prime contractor (airframe) during the war (now reconverting to non-aeronautical product). Has valid commercial pilot, seven ground instructor, A. & E., radio operator, and F.A.I. glider pilot certificates. Familiar with latest metal, plastic bonded wood, and composite aircraft techniques; also conventional, amphibious, and rotating wing aircraft. Desires position where knowledge, experience, initiative, and results are of prime importance. Last salary—$7,000. Address inquiries to Box 453, Institute of the Aeronautical Sciences.

Aeronautical Engineer—With own design of practical roadable airplane having basically new and desirable features seeks connection with aircraft manufacturer who has well-established manufacturing facilities but needs a product. M.I.T. Graduate with 10 years' sound aircraft engineering experience. Address inquiries to Box 447, Institute of the Aeronautical Sciences.

Aircraft Design Engineer—Has aeronautical education. Seven years' experience in many phases of aircraft design, including layout drafting, testing, and liaison on aircraft equipment installation. Desires responsible position in engineering or experimental department of small aircraft or air-

craft equipment manufacturer, or air line. Willing to travel. Address inquiries to Box 445, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Twenty-two years old. Will graduate March 29, 1946, from aeronautical school. Has lived in Spanish-American country for 16 years. Writes and speaks Spanish and English fluently, thoroughly acquainted with Latin customs. Desires position in which engineering training and knowledge of Spanish and English would be of value, either in the United States or Latin America. Address inquiries to Box 444, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in A.E.; age 32. Experienced in layout, design, stress analysis, and supervision in plywood and all-metal aircraft and helicopters including basic design and simplification of structures. Desires position in Mid-West if possible. Present location, Detroit. Address inquiries to Box 441, Institute of the Aeronautical Sciences.

Mechanical Engineer—M.S.E.; 32 years old; with good background in mathematics, applied mechanics, vibrations. Varied experience in research, development, and testing of mechanical products. Thoroughly familiar with mechanical laboratory methods and equipment. Desires position requiring such knowledge and experience, preferably with research and development organization. Address inquiries to Box 440, Institute of the Aeronautical Sciences.

Engineer—Administrative Liaison—Aeronautical Administrative Engineer—Seven years' air-line operation maintenance experience with international air line and U.S. Naval Air Transport Service. Lieutenant Commander, Squadron and Staff Engineering Officer. B.S. in Mechanical Engineering (Aero Option), University of California. One year, Harvard Business School. Permanent position with international transportation concern desired. Available immediately. Address inquiries to Box 439, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Fourteen years actively engaged in the aircraft industry, including project design, flight test, and development engineering, and as representative in procurement and field service. Thorough knowledge of maintenance and flight operation, including A. and E. licenses and 7 years' flight experience. Present affiliation with major aircraft company, entered in 1937. Desires permanent responsible position and opportunity for advancement, commensurate with ability, in development, sales, or as technical representative. Geographical location unimportant. Four years of university work and graduate of two leading schools of aeronautics. Understands Spanish and French. Excellent commercial and military references. Address inquiries to Box 436, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E., University of Minnesota. One year detail design and minor layout drafting. Over four years' service with Air Technical Service Command, U.S.-A.A.F., as engineering officer. Military experience included one year of checking contractor-submitted stress analyses and the design and supervision of installation, in aircraft, of experimental equipment; three years as resident liaison engineer for A.A.F. at large West Coast aircraft manufacturer. Served three months in England and Germany with Air Technical Intelligence Section of U.S. Strategic Air Forces as technical investigator of German aircraft development. Desires permanent position with opportunity for advancement in technical or administrative engineering or allied field. Los Angeles area preferred. Available immediately. Address inquiries to Box 435, Institute of the Aeronautical Sciences.

Engineering Draftsman—Four and one-half years' experience in aircraft work, 1 year, sheet metal layout; 6 months, tool design; 2 years, aircraft hydraulics; and 1 year, shop liaison. Three years of college. Desires position in Chicago area with organization offering future. Will consider position in other than aircraft industries, but aircraft industry preferred. Draft exempt. Excellent references available June 1. Address inquiries to Box 433, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate work in Ae.E. Almost 6 years' experience in flight test, stability and control, and wind-tunnel testing on multiengined landplanes and seaplanes with large company. Desires stability and control or flight-test work with West Coast air line. Address inquiries to Box 432, Institute of the Aeronautical Sciences.

Engineer—Manufacturer—Eighteen years in aircraft industry. Experienced as Chief Engineer of large aircraft company during the war. Also experienced in operation of own company manufacturing subcontract aircraft parts. Desires position with small company having proprietary articles to engineer, manufacture, and sell. Have private pilots' license and fly own light airplane. Address inquiries to Box 431, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Officer R.C.A.F. Engineering education. Six years' aircraft maintenance, liaison inspection and engineering in manufacture and overhaul of military aircraft. Considerable technical administration work. Glider construction and design experience. Desires position whereby technical qualifications can be utilized and experience to a more advanced standing possible. Future opportunity is the prime requisite. Address inquiries to Box 430, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Five and one-half years' experience in Airline Engineering (Operation and Maintenance) and Aircraft Manufacturing. Two degrees in Aeronautical Engineering. Part time work desired. Address inquiries to Box 429, Institute of the Aeronautical Sciences.

Engineer—World War II veteran, engineering degree. Eight years' flying experience in U.S. Navy, 4 years service engineering, 2 years test-pilot and development work. Qualified in various types service planes including single and multi-engine, both land and sea. Recent experience in jet-propelled aircraft. Desires opportunity to do research and development work including flying. No objection to traveling. Excellent references. Address inquiries to Box 427, Institute of the Aeronautical Sciences.

Air Passenger Research—College graduate, experienced. Available temporary or permanent. Address inquiries to Box 426, Institute of the Aeronautical Sciences.

Chief Engineer, Mechanical, Development and Research—Wide experience, automotive and aeronautical, ball and roller bearings and all applications, gears, landing gear; initiated current propeller; mature judgment, capacity for detail, executive experience. Ability to analyze new design, foresee possibilities, and carry from start to production drawings. Now have paying consulting business but prefer direct responsibility. Address inquiries to Box 425, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Graduate with eighteen years of practical experience in aircraft design and engineering with emphasis on aerodynamics, wind-tunnel testing, flight-testing, power plants and weights control. Desires a supervisory position in connection with aircraft design and development engineering or flight test. Address inquiries to Box 423, Institute of the Aeronautical Sciences.

Aeronautical Engineers—Recently incorporated organization of experienced engineers is interested in designing a complete airplane or any of its parts. Aerodynamic, structural, and power-plant installation problems capably executed. Complete responsibility will be assumed for obtaining C.A.A. approval. The diversified background of our engineering staff in designing for production assures a product which not only incorporates

sound engineering, but also can be manufactured economically. Address inquiries to Box 422, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.Ae.E. degree. Five and one-half years' experience in stress analysis and design of large aircraft structures with a large eastern concern. Familiar with all parts of the airplane. Part time spent as group leader. Mid-West location preferred. Would like airline work. Address inquiries to Box 421, Institute of the Aeronautical Sciences.

Engineer—One and one-half years' experience as structural test engineer and stress analyst with major aircraft company. M.E. graduate of Lowell Institute School, M.I.T. No objection to traveling. Address inquiries to Box 420, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S. in Ae.E. with approximately 12 years' experience in military and civil airplane engineering. Complete structural responsibility on recent Navy and Army fighter airplanes with large organization. Inventive ability and productive minded. Knowledge of loads, vibrations, and flight testing. Experienced in supervising large group. Desires a permanent and responsible design or stress position in progressive organization in East or Middle West where his experience and abilities can be fully utilized. Address inquiries to Box 419, Institute of the Aeronautical Sciences.

Aeronautical Engineer, Executive—B.Ae.E., age 33, Commander U.S.N.R., available shortly. Seven years' experience in design, development, modification, overhaul and maintenance of naval aircraft, both production and experimental types. Particularly strong on structures. Administrative experience. Desires responsible position where initiative and capabilities can be employed. No objection to traveling. Willing to locate anywhere. Will consider affiliation with progressive nonaircraft organization. Address inquiries to Box 418, Institute of the Aeronautical Sciences.

Aeronautical Engineer—Bachelor's and Master's degrees in aeronautical engineering. Eight years' experience with Army, Navy, and commercial types covering all existing types of construction. Experienced in aerodynamics, structures, basic and detail design, and development and experimental work. Good knowledge of shop practices and thoroughly familiar with C.A.A. design requirements, including new CAR 03. Prefers work on small and medium-sized commercial aircraft. Any location considered. Address inquiries to Box 417, Institute of the Aeronautical Sciences.

Aeronautical Management Engineer—Registered professional aeronautical engineer with over 18 years' broad supervisory experience in aircraft engineering and production. Organization, Methods and Procedures, and Maintenance. Five years as Mechanical and Electrical Engineer. Will set up or improve organization, administrative and other control procedures, production and inspection methods and procedures, production and maintenance design; cut manufacturing, operating, and maintenance costs, initiate and maintain liaison with Government and industry for Air Line or Aircraft Manufacturer. Recently Chief, Maintenance Control and Chief, Methods and Procedures, for 2 years with U.S. Army Strategic Air Forces and Air Technical Service Command. Address inquiries to Box 416, Institute of the Aeronautical Sciences.

Executive Engineer—Graduate engineer with eight years' aircraft experience including production planning, cost estimating, master scheduling, and past five years senior design engineer. Prefers Mid-West location in aircraft or allied field. Address inquiries to Box 415, Institute of the Aeronautical Sciences.

Manufacturing Executive—Twenty years' experience, mostly aircraft, all phases manufacturing and procurement. Specialized in planning, material control, estimating, production control, procurement and production management. Available immediately. Address inquiries to Box 412, Institute of the Aeronautical Sciences.

Aeronautical Engineer—B.S Ae.E., and C.A.A. Aircraft Mechanic Certificate. Experience consists of seven months in aircraft manufacture while attending college, and two years, since graduating from college, in maintenance and design engineering on four-engined transports for commercial airline. Interested in position with another air line, manufacturer's field service technical representative, or similar work. Any location considered. Address inquiries to Box 406, Institute of the Aeronautical Sciences.

Aeronautical Engineer (native Russian)—Would like to translate Russian scientific and technical papers. Thoroughly acquainted with the field of theoretical and applied aerodynamics. Address inquiries to Box 405, Institute of the Aeronautical Sciences.

Aeronautical and Mechanical Engineer—B.S., S.M. Broad experience in theoretical and experimental stress analysis, vibration theory, and instrumentation. Project organization and customer liaison work. Long residence in the Orient. Speaks and writes Russian fluently; some French and Chinese. Interested in responsible position with consulting firm or similar organization having foreign contacts. Address inquiries to Box 404, Institute of the Aeronautical Sciences.

Development Engineer—Aeronautical engineering degree, industrial management training. Five years' experience in aircraft engine design and research aircraft production, editing. Ideal assistant for busy executive. Will conduct correspondence and technical writing, assist in project administration, planning and coordination, or handle strictly technical assignment. Address inquiries to Box 400, Institute of the Aeronautical Sciences.

Production Executive—Mechanical engineer with 5 years' administrative experience in all phases of aircraft construction, including line assembly methods and tool and jig design, and one year as Director of Experimental. Served 10 years as Works Manager of large plant fabricating precision metal parts for automatic actuating mechanisms. Thoroughly familiar with modern precision machine-shop practice serving 8 years as Plant Manager. Manufacturing experience totals 26 years. Automotive background. Enjoys a wide acquaintance among subcontractors in central and eastern area. Will travel. Address inquiries to Box 292, Institute of the Aeronautical Sciences.

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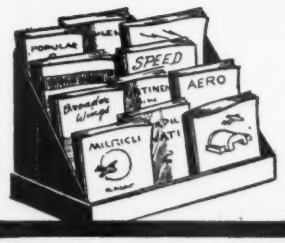

Periodicals

Accessories and Equipment

Liquid Springing. The design, operation, aircraft applications, and advantages of a new compressing apparatus for liquids are described. Developed by Dowty Equipment, Ltd., this liquid spring is credited with effecting a saving in weight and is recommended in the article for the springing of main wheels and tail wheels in aircraft. It is said to consist essentially of a steel cylinder containing a piston and rod, the latter passing through a high-pressure gland. Not a pressure head as a standard piston usually is, the piston of this device serves to divide the cylinder into two compartments between which communication is maintained by means of a clack-valve and orifices in the piston. The cylinder is completely filled with oil to the exclusion of all air. When a load is applied, the piston and rod are forced into the cylinder, and the decreased capacity available for the oil, because of the volume displaced inside the cylinder by the rod, induces compression of the oil. *Flight*, January 24, 1946, page 95, 3 illus.; "Dowty Liquid Springing," *The Aeroplane*, January 25, 1946, page 104, 3 illus.

Gasoline Explosion Pressures. M. S. Plesset and F. R. Gilmore. The authors describe an investigation initiated to form a conception of the temperatures and pressures developed in aviation combustion heaters under the assumption that an explosion takes place. A numerical method that permits the calculation of the temperatures and pressures obtained when mixtures of air and aviation-gasoline vapor are exploded in a closed chamber is outlined. The calculations use basic thermodynamic data to determine the final equilibrium state of the air and gasoline mixtures after combustion. Experimental measurements of the explosion pressures were made using an explosion bomb with a strain-gage pressure pickup. The measured pressures were of the same order of magnitude as the calculated pressures but, in general, were somewhat above the theoretic values. Some possible explanations for this trend are included. *Transactions of the A.S.M.E.*, February, 1946, pages 89–97, 7 illus.

Westland Cabin Atmosphere Control. A review of components and installations, as produced by Westland Aircraft, Ltd., for a typical cabin interior "atmosphere control" system. The system, chosen for giving an overall picture of the equipment and problems involved, is one employed for a high-speed luxury passenger aircraft designed to operate at 25,000 ft. The figure of 25,000 ft. is used in connection with a differential pressure of $5^1/_2$ lbs. per sq.in. to yield a cabin interior pressure equivalent to atmospheric pressure at 8,000 ft.

Following a description of the sequence of airflow through the various units in the typical system, several components are examined individually. Schematic drawings of various components are included, together with a diagrammatic section through the cabin which depicts the disposition of conditioning-equipment components and airflow paths in the typical installation. The article calls attention particularly to the rate of air change, the means by which the air is cooled, the tandem discharge valve, the automatic pressure control, and equipment for ground conditioning of the aircraft in intemperate climates. *Flight*, January 31, 1946, pages 105–107, 7 illus.; "Cabin Air-Conditioning in Air Liners," *The Aeroplane*, February 1, 1946, pages 150–153, 8 illus.

The A.B.C. Airborne Auxiliary Power Plant. Design, construction, and operational features of the Type III A.B.C. auxiliary power plant are examined. Developed for the Short Seaford flying boat, the engine of this unit is cited as an example of the horizontally opposed twin-cylinder air-cooled type. Lubrication details are noted. Two other features accorded special emphasis are the Ricardo three-throw crankshaft, which avoids the rocking couple prevalent in horizontal opposed piston engines of normal design, and the fans mounted in front of each cylinder by which forced draft for air-cooling is obtained. Other features included are the governor, pumps, generator, and lubrication system. Specifications of the power plant are listed. *The Aeroplane*, January 11, 1946, pages 47, 48, 3 illus.

Heating and Ventilating for Transport Airplanes. B. M. Brod. Present methods used in heating and ventilating transport aircraft are described in a paper presented at the 52nd Annual Meeting of the American Society of Heating and Ventilating Engineers. The selection of the designed outside and inside temperatures for an aircraft heating system is considered, and the determination of the size of an airplane's heating system is outlined. It is stated that present customary practice is too rough and ready. Ventilating requirements are included. The writer then analyzes the various features of the steam system, the exhaust heat exchanger, and the internal-combustion heater. He also discusses duct systems, automatic control, and future considera-

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tions. *Heating, Piping & Air Conditioning*, January, 1946, pages 124–129, 8 illus.

Safer Flying. A type of crashproof fuel tank that gives a substantial measure of protection against fire is described. Designed and manufactured by the Henderson Safety Tank Company, Ltd., the tank is reported to be basically a sandwich shell. It consists of an inner shell of welded construction and an outer shell with folded-seam joints. A layer of rubber separates the two shells. Related details of the baffle attachment are illustrated. Advantages of the tank are indicated, and weights and costs are specified. *Flight*, January 31, 1946, pages 120, 122, 4 illus.

Aerodynamics

Airfoil Development and Structure Within the Cambered Surface. Part IV. Roy A. Liming. In the fourth section of a serial article the writer extends the analytic principle, developed in the preceding section of the article for "rigging" a wing by the reference plane system, to the "rigging" of a wing by the chord plane system involving multiple rotations in space. He explains the analytic "rigging" of the basic lines of a wing lofted by the chord-plane system, which may involve the rotation of the chord plane of the wing through more than one angle—for example, a dihedral angle and a uniform angle of incidence. He reviews the basic analytic principles that govern rotation of axes in general and proceeds to the algebraic formulas by which the wing-chord system coordinates of any point and the "rigged" coordinates of the point may be calculated. An example is worked out by the substitution of figures from a data table, showing the computation of the "rigged" coordinates of the intersection of the centerline of a landing-gear trunnion with the centerline of an oleo strut. In a similar manner, the essential steps in the analytic derivation of the required constants for the "rigged" equations of a wing master line are outlined. The equations are used to calculate vertical wing sections for the coordination of fuselage and wing, the development of wing-to-fuselage fillet fairings, attachment fittings, and vertical rib contours. Buttock and water plane intersections with any skewed line in the wing development—for example, such elements as the flap, aileron, or landing-gear rotation axes, spar mold lines, or other basic structural lines—may be determined with such "rigged" equations. *Aero Digest*, February, 1946, pages 47–49, 111, 5 illus.

"Carpets" and "Lattices." A. H. Yates. A novel method of plotting a function of two independent variables recently used in aeronautics is described. How the idea can be extended to include three independent variables is explained. The results of experiments in various aeronautical problems are depicted in "carpet" form, with a "lattice" obtained by adding a further variable. *Aircraft Engineering*, January, 1946, pages 8, 9, 9 illus.

Mathematical Theory of Gas Flow. Part II. Max M. Munk. Having established in the first part of a serial article the formal mathematical foundation for the study of the theory of gas flow, the writer proceeds to explain the necessity for the substitution of a hypothetic gas for air, despite the moderate errors in the results. The discussion is restricted at first to Molenbroek's transformation and the subsonic flow, leading to a pair of partial differential equations with a variable multiplier and to the principle of the "linearization" of equations. Chaplygin's discriminant is explained with the aid of a diagram, giving a comparison with a discriminant suggested by the writer. It is shown that the expansion curve of Chaplygin's hypothetic gas is a tangent to the expansion curve of air, the point of tangency indicating the pressure and density at the impact point. The use of the term "linearization" is qualified, and reasons are given for the use of a substitute expansion-curve line.

The question is then examined from an entirely different angle and from a more intuitive point of view by reference to Cauchy's equations governing the flow of electric current through a sheet of metal. Following an explanation of the substitution in connection with one of the given equations, the examination turns to the equivalent condition having reference to the reciprocal transformation. It is noted that the expansion curve of the hypothetic gas leading to the plain-wave equation in connection with the reciprocal transformation is not straight and that there does not seem to be any significance to the shape. It is concluded that the substitution of the hypothetic gas on the basis so far considered is limited to low velocities in relation to Molenbroek's transformation and to supersonic velocities having a local Mach Number equal or close to the square root of 2.5 in relation to the reciprocal transformation. *Aero Digest*, February, 1946, pages 52, 142, 144, 1 illus.

Air Cargo

World Air Cargo. Nathan Habib. The future prospects for air-cargo transport are studied. It is predicted that air freight will be the biggest international air-line pay load by 1955. The role of air transport in the foreign trade of the United States during the war is discussed. Figures reveal the rapid growth of air cargo during the war years. *National Aeronautics*, February, 1946, pages 9, 18, 31, 1 illus.

Air Law

Aviation Transport. The entire Winter-Spring, 1946, issue of the periodical *Law and Contemporary Problems*, published by the Duke University

IMMEDIATE OPENINGS FOR
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School of Law, is given to a symposium on the legal aspects of air commerce. It does not purport to be a complete compendium; various topics have been omitted, such as the financing of flight equipment, the development of standards and policies under the Civil Aeronautics Act, conflict of law development, the relation of air-mail policy and rate regulation, and others. This symposium presents primarily a series of surveys of an economic and legal nature centering about the role of aviation, regulation and legal liability, including taxation, and some recent international developments.

In the first article, "The Economic Rôle of Air Transportation," Irston R. Barnes, C.A.B. economist, presents an appraisal of air transportation's present economic significance and characteristics, as well as of its anticipated developments. Also of an economic nature is an article on "Possibilities for Lower Airline Costs," by the economist Joseph L. Nicholson, who points out some of the obstacles to optimistically low air rates.

"Federal, State, and Local Jurisdiction Over Civil Aviation," by Charles S. Rhyne, is a comprehensive survey of the diverse Governmental spheres of action and regulation. This is followed by a discussion of "Appropriate Areas of State Economic Regulation," by Frederick G. Hamley, of the National Association of Railroad and Utility Commissioners, who presents the frequently neglected statement of the case for the states. A further field of regulation, and one in which considerable developments may be expected, is explored by George C. Neal, General Counsel of C.A.B., under the title "The Status of Non-Scheduled Operations Under the Civil Aviation Act of 1938."

Legal liability is introduced in the next article by Paul Reiber, of the Air Transport Association of America, commenting upon "Some Aspects of Air Carriers' Liability"; touching on such matters as surface damage, personal injuries, *res ipsa*, and limitation of liability; and suggesting a balance of the conflicting interests. Fitting in with the foregoing is the seventh article, by John Hunter, of C.A.A., which goes into various aspects of the field of airport law under the title "The Conflicting Interests of Airport Owners and Nearby Property Owners." That "Aviation Law Comes Home to the Main Street Lawyer" is demonstrated by John C. Cooper, retired Vice-President of Pan American Airways System, who makes helpful suggestions to the lawyer engaged in the aviation-law field.

An informative discussion of the need and prospect for legislation is contributed by Stuart G. Tipton, Acting President of the Air Transport Association of America, in "Legislative Program for Aviation."

An analysis of the competing considerations underlying the tax problem is given by Ronald B. Welch, of the Bureau of Internal Revenue, in his article on "The Taxation of Air Carriers."

The last two articles deal with international matters. An interesting light on "Influences Affecting International Aviation Policy" is given by Thomas Burke, who was for a number of years Chief of the Division of International Communications of the Department of State. The last article in the symposium, "Sequels to the Chicago Aviation Conference" by Richard K. Waldo, Department of State, presents the developments that have taken place as the aftermath of the United Nations' Aviation Conference in 1944. *Law and Contemporary Problems*, Winter-Spring, 1946.

The views and opinions expressed in this section are exclusively those of the writers or publications named. They are in no case to be construed as those of the Aeronautical Engineering Review or the Institute of the Aeronautical Sciences.

Air Transport

Australia in Empire Air Transport. W. Hudson Fysh. In the first British Commonwealth and Empire Lecture of The Royal Aeronautical Society, the Managing Director of Qantas Empire Airways discusses Australia's place in the air-transport system of the British Empire. After touching on the antiquity of transport and its historical foundations in the British Isles, he reviews Australia's pioneering history in the air and describes the position in which the Commonwealth finds itself today. Some of the phases of the subject dealt with include early sea, air, and land communications; air-route pioneering in Australia; Empire air development, especially as it affects Australia; Australia as an aircraft market; and future developments. The war services of Qantas Empire Airways are outlined. Numerous charts give statistics about air-transport operations. *The Journal of The Royal Aeronautical Society*, January, 1946, pages 21–72, 32 illus.

Europe's Challenge. James L. H. Peck. Some idea of the competition that will be offered the United States by European nations in the field of international air transport is given by short comments with regard to the published plans of the various nations and brief reviews of the forthcoming planes that each country is making ready for long-distance air transport. The plans, actions, and aircraft observed are those of Great Britain, France, Holland, Russia, Sweden, Denmark, Norway, and Poland, with Great Britain indicated as the greatest competitor. *Air Trails*, March, 1946, pages 32–35, 84, 86, 21 illus.

Integration. Part II. Henry A. Palmer. The second of a series of articles by different writers discussing the pros and cons of a set of proposals for the integration of the various forms of transportation. The Vice-President of the Transportation Association of America, originator of the proposals, explains the desire of the railroads and steamship lines to enter the air-transport field. *National Aeronautics*, February, 1946, pages 17, 18.

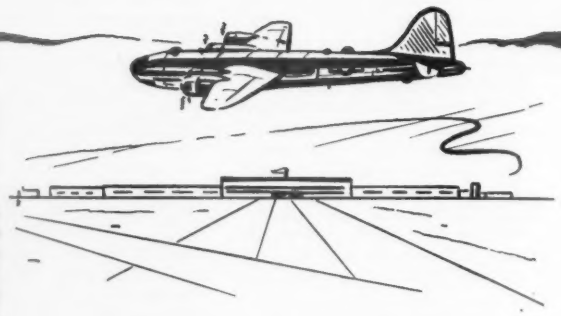
In Alaska . . . Everybody Flies. Jennings Randolph. A United States Congressional Representative comments upon the economic development opportunities that will be opened in Alaska through air transportation. Comparing climatic conditions of Alaska with those of more populous Norway and Sweden, he claims that Alaska suffers no disadvantage except for its relation to the world's population centers and the transportation services that connect it with those centers. He goes on to show that, with air transportation and the airways and airport facilities established in Alaska during the war for military reasons, this handicap has been removed. Some of the changes and additions that will be required to adapt these facilities for civilian air-transport purposes are noted. The article also briefly outlines Alaskan industries that are using air service and Alaskan products that are being shipped by air. *Skyways*, March, 1946, pages 24, 25, 66, 68, 6 illus.

Accident Analysis. The accident record of the R.A.F. Transport Command is analyzed, and the Command's accident figures are compared with those for civil aviation during the years 1934 to 1938. In the examination of the Command's record, individual figures are given for the Scheduled Services and the Trooping Services, as well as combined figures for both. Figures for prewar civil aviation are divided into accident percentages for Belgium, Holland, France, Switzerland, Sweden, United States, and Great Britain. *Flight*, January 17, 1946, page 67.

Skyway Foreign Trade. John B. Crane. How improved air transport may be expected to affect the volume and character of international trade is discussed in sections dealing with passenger and cargo traffic, respectively. Estimates of the probable amount of international passenger and cargo traffic in the year 1950 are based on previously published data. *Air Transportation*, January, 1946, pages 26–28 2 illus.

Liberty or License for Little Aviation? Capt. Allan H. Gillis. The question of whether C.A.B. regulations should be imposed upon nonscheduled air carriers is investigated. The stand of the air lines advocating regulation and that of the fixed-base operators

IT'S A RECORD!



Aviation records make news these days at the rate of about one a week. In just two months, these eight new speed-distance marks were logged:

Guam to Washington, Army "Dreamboat," November 20, 1945 . . . Hartford to Seattle, Army "Dreamboat," December 8, 1945 . . . Paris to Washington, T.W.A. "Paris Sky Chief," December 9, 1945 . . . Seattle to Burbank, Army "Dreamboat," December 11, 1945 . . . Burbank to New York, Army "Dreamboat," December 11, 1945 . . . New York to Bermuda, Pan-American, January 14, 1946 . . . Bermuda to New York, Pan-American, January 15, 1946 . . . New York to Portugal, Pan-American, January 20, 1946.

CECO Carburetors were on the planes which set all of those records. Was that a coincidence? We'll leave the answer to you, as we pledge continued research and development toward the records of tomorrow — and tomorrow.

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opposing it are interpreted. However, with indication of the many noncertified carriers now entering the air-transport field, the general conclusion is that regulations should be drafted and adopted now. Several possible methods of regulation considered by the C.A.B. are outlined. *Flying Age*, February, 1946, pages 10, 11, 54–57, 3 illus.

The Future of World Airlines: Africa. Lucien Zacharoff. The commercial aviation potentialities of Africa are considered in a continuation of a series of articles on the civil air-transport prospects of various countries. Noting the contribution of military operations to peacetime air-transport systems in Africa, the writer outlines the action that has been taken and the plans that are contemplated for internal and external African air services. The discussion takes into its scope the varying programs for the British African territories, the French African countries, the Belgian African Areas, and Egypt. Nations operating air lines in Africa are listed. *Air Trails*, March, 1946, pages 43, 76, 78, 1 illus.

Post-War Australia Aims High. Lloyd Clarke. Australia's civil aviation future is estimated and the Dominion's aims for air-line expansion are considered. With the aid of a map, the writer explains Australia's advantageous position as a world air-line center. It is stated that projected services will depend to a considerable extent on agreements that are being sought among America, Great Britain, other members of the British Commonwealth of Nations, France, and Russia. Parts of an announcement made by Australian Civil Aviation Director Daniel McVey regarding the government's intention to reach an air-transport agreement with the United States are quoted and discussed. *Air Transportation*, January, 1946, pages 14–16, 3 illus.

Airplane Descriptions

The Avro Lincoln. A comprehensive review of the Avro Lincoln bomber is supplemented by sectional drawings, photographs, charts, and tables of data. In the investigation of the design, operational, and handling characteristics of the Lincoln, differences from, and similarities to, the predecessor Avro type, the Lancaster, are discussed throughout the article. Powered by four Rolls-Royce Merlin 85 engines of 1,750 b.hp., each driving 13-ft. diameter for-bladed hydromatic propellers, the Lincoln is cited for three primary attributes—great bomb load, high performance, and long range. *Flight*, January 17, 1946, pages 57–62, 17 illus.; "The Avro Lincoln," *The Aeroplane*, January 18, 1946, pages 77–82, 8 illus.

A Commentary on English Post-War Civil Aircraft. S. Veale. A list of airplanes planned by the British for civil purposes in the near future is reviewed. The brief descriptions offered are those pertinent to the Percival Merganser; de Havilland Dove and Dragon-Rapide; Avro XIX; Tudor I, Tudor II, and York; Miles Aerovan and Marathon; Vickers-Armstrongs Viking; Airspeed Ambassador; Bristol Freighter and Wayfarer; Handley Page Halifax Transport and Hermes; Short Stirling, Sandringham, and Shetland; and the Bristol Brabazon I. *Commercial Aviation*, January, 1946, pages 46, 47, 4 illus.

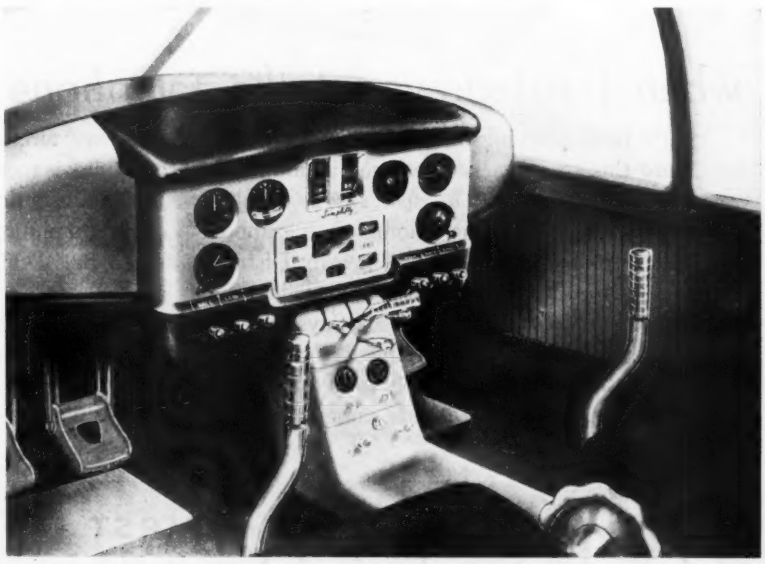
The D.H. Hornet. In a comprehensive study of the design and construction of the de Havilland 103 Hornet, features of the Sea Hornet version are also reviewed. Pertinent details are surveyed with reference to the Hornet's power plants, fuselage, tail, wings, component materials, induction air intakes, wheels, tanks, controls, cockpit, armament, etc. Drawings, photographs, and tabulations of principal data and performance figures supplement the study.

The Hornet is described as a two-engined fighter of combined wood and metal construction. A smaller version of the Mosquito, it is powered by one Merlin 130 and one Merlin 131 engine, compactly installed. The general specifications to which the Hornet was designed called for speed, climb, maneuverability, and a range in excess of that of existing fighters. *Flight*, January 24, 1946, pages 85–90, 16 illus.; "The De Havilland Hornet," *The Aeroplane*, January 25, 1946, pages 107–111, 9 illus.

A New Cunliffe-Owen Project. A brief description is given of the first postwar design produced by Cunliffe-Owen Aircraft, Ltd. This is called the Concordia, a ten-passenger all-metal airplane powered by two 500-hp. Alvis Leonides radial air-cooled engines. The construction of the fuselage, wing, and retractable landing gear is described, with additional details concerning the electrical system of actuating accessories, the equipment in the cockpit, and the accommodations provided for the passengers. The specifications, dimensions, and performance, as well as three-view drawings, are included. *The Aeroplane*, February 1 ,1946, page 128, 1 illus.

Burnelli CBY-3 Air Transport. Features of the CBY-3 combination passenger and cargo plane are reviewed. Built by the Canadian Car & Foundry Company, Ltd., from the basic design created by the Central Aircraft Corporation under the direction of Vincent J. Burnelli, the CBY-3 is reported to embody the Burnelli principle of design. This calls for the use of a wide, relatively short fuselage, constituting in effect the center portion of a flying wing and offering a number of advantages, which are indicated. The two engines of the CBY-3 are located at the forward end of the wide fuselage, with the propeller axes close together. High tail surfaces are clear of wing and fuselage interference. Passengers are housed at the rear of the fuselage; cargo, at the forward end. Normal accommodations are for 24 passengers. Performance data and specifications for the CBY-3 are listed in the article. There is a photograph showing the plane in flight, and schematic drawings of overhead and head-on views of the transport depict its dimensions and the distribution of passengers, baggage, and cargo. *Aero Digest*, February, 1946, pages 50, 51, 107, 3 illus.

A British Design for the Atlantic Route. A scheme is advanced for a



Culver Aircraft Corporation's "Simpli-Fly" control system, as used in the Culver Model B. Turning the flight-control wheel, shown at the lower right between the seats, moves the indicator at the top center of the instrument panel, to the desired flight attitude, and the airplane is caused to trim itself automatically.

when I sat down at the telephone

"I'd been noodling for a long time . . . was sure this spar bracket designed as an Alcoa 75S-T forging would be *right*. But as usual—you know—doubting Thomases. I grabbed the telephone, called Alcoa's nearby District Sales Office, got Charlie Brown, described the bracket and loads to be imposed. Says Charlie, 'Sure we can make a forging like that, and handle it in 75S-T'. Says I, to my doubting Thomases, 'See, great minds, same channel'."

To all aircraft engineers, the above bit of byplay is meant to get over just one point. If you are in doubt about any characteristic of an aluminum alloy . . . call your nearby Alcoa Sales Office. There, you will get the *rightest* answers, supported by the greatest fund of knowledge about aluminum that can be found anywhere.

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transatlantic air liner weighing 185,200 lbs. Prepared by Flight Refuelling Ltd., the F.12 projected design has been prepared with the object of constructing an aircraft specifically designed to make optimum use of refueling in flight, as opposed to the adaptation of an existing type for the purpose. The design calls for a large cubic capacity and pay load, with as high a disposable weight as possible. It is based on a "figure 8" double-deck fuselage that lends itself to pressurization and provides more nearly vertical sides than a circular fuselage. Night accommodation is for 100 passengers; day accommodation, for 134. General data of the projected F.R. 12 are tabulated, and cross-sectional views of the design are shown. *The Aeroplane*, January 18, 1946, pages 86, 87, 2 illus.

Sea Fury X. An evaluation of the characteristics and merits of the design, construction, performance, and components of the Hawker Sea Fury X. The general conclusion is that, although the Sea Fury is a high-quality airplane with an outstanding rate of climb, as a fighter judged on present standards it is eclipsed on every count, except that of range, by the jet types.

Among the components of the Fury to which particular emphasis is given in the article are its tail surfaces and its hydraulically operated wing-folding gear. Principal data and performance figures are listed; a cross section of the entire plane and illustrations of various of its parts are shown; and differences between the Fury and its predecessor type, the Tempest, are indicated. *Flight*, January 31, 1946, pages 111–116, 14 illus.; "The New Hawker Fury," *The Aeroplane*, February 1, 1946, pages 137–144, 13 illus.

A Norwegian Amphibian. This article concerns the design and construction of the Hönningstad 5A, a ten-seater amphibious aircraft being manufactured in Norway. The 5A is reported to be of generally orthodox design—that is, it is a high-wing monoplane with two radial engines mounted on the leading edge of the wing and sponsons for lateral stability on the water—but certain uncommon features are viewed in connection with the wheel and ski combination from which the amphibious characteristics of the undercarriage are derived. Range of the 5A is placed at from 435 to 1,550 miles, depending on tanks and pay load; maximum speed, at about 180 m.p.h.; and service ceiling, at 19,700 ft. *Flight*, January 17, 1946, pages 53, 54, 2 illus.

Airports and Airfields

Aluminum Airplane Hangar. A newly developed aircraft hangar that will be constructed entirely of aluminum is described. It has been named the "Silver T" by its designers, the Airport Facilities Corporation, of Chicago. The hangar is made of low arched sections and is shaped like a cross. Hangar doors have been eliminated by equipping the sections with roller-bearing wheels so the sections can be rolled away, leaving only the tail of the plane enclosed. *Modern Metals*, February, 1946, page 31, 1 illus.

The Riverdrome Scheme. Wing Commander R. A. C. Brie. The writer gives an account of his airport-terminal communication plan. Helicopters would be operated from floating platforms on the small rivers that pass through many British towns and cities. Advantages of the idea and the problems that might be solved by it are described. *Aeronautics*, February, 1946, pages 40, 41.

Durability of Concrete at an Airfield. It is reported that three severe winters with their several cycles of alternate freezing and thawing have left no marked effect on the concrete paved runways, taxiways, and aprons of the Bunker Hill Naval Air Station, near Peru, Ind.; nor has the application of calcium and sodium chlorides, employed as deicing agents, caused deterioration of the concrete. Credit for this durability is attributed to a cement-dispersing agent that was added to lubricate the mix because there was a lack of sufficient fines in the sand aggregated. *Engineering News-Record*, February 21, 1946, pages 80, 81, 3 illus.

Standardized Fees for Airport Users. Leigh C. Fisher. Citing the need for, and the advantages of, such a system, the writer urges the establishment of standard rates and charges for application to airport operations. Specific applications suggested are in landing fees, terminal-building rental charges, hangar rentals, ground leases, airport use charges to nonscheduled aircraft, and charges to concessionaires. It is further recommended that sound cost-accounting methods form the basis for the schedule of charges.

As the most satisfactory and financially practical method of charging for scheduled aircraft landing fees, a system using weight as the determining factor is outlined. The writer also offers the suggestion that the establishment of standard charges gives the community an opportunity to put the airport on a profitable basis and that earned surpluses can be used for the development and improvement of airport facilities. *Southern Flight*, February, 1946, pages 44, 46.

What About New Airports? William L. Hyland. Indicating the national need for more airports and stating that the National Airport Plan will not adequately fulfill the specific needs of certain metropolitan areas, the writer examines some of the costs and other considerations involved in building private airfields. His thesis is based upon the cases of three typical New England sites that are reportedly inexpensive to develop. The cases involve: (1) a site in the western part of Massachusetts, now used for farming; (2) a site in the central part of Massachusetts, currently unused; and (3) a site on the Massachusetts coast line, largely wooded and not used at present. *Yankee Pilot*, February, 1946, pages 8, 9, 1 illus.

Fog Cutter. Phil Buskirk. Principles and operation of the Nofog airport fog-dispersal process are explained. The process is based upon the use of special chemicals that, heated to 1,600°F., arise in the air and reduce its relative humidity. This is reported to enable the atmosphere to absorb some of the fog, carry away the remainder, and drop the excess like rain. In addition to describing the action and applications of Nofog, the article also indicates the differences between this and other fog-dispersal devices, particularly the British FIDO (Fog Investigation Dispersal Operations) used during the war. *Flying*, March, 1946, pages 24, 25, 103, 104, 106, 6 illus.; "Out of the Fog," Tamara Andreeva, *Western Flying*, February, 1946, pages 46, 58, 2 illus.

The "Square-T" Four-In-One Hangar. Vida Foster. Particulars are given regarding the design, construction, merits, and cost of a prefabricated all-steel unit for housing four airplanes in "T" hangar fashion. Manufactured by Star Manufacturing Company, the "Square-T" hangar is 57 by 56½ ft. Each of the four "T" cells has a clear door opening of slightly more than 41 ft. The clear height from the bottom of the door track to the top of the foundation is 9 ft. 9 in. The tail section is 14 ft. deep and 14 ft. wide, and the wing section is 14 ft. deep and 42 ft. wide. The clear height inside each unit is 10 ft. A curved roof is supported by a specially designed structural-steel cantilever truss, which permits suspension of doors on four sides. The all-steel doors are built in three panels, each 14 ft. wide and 10 ft. high. *Southern Flight*, February, 1946, page 54, 1 illus.

New Airport Plan Designed to Interest Non-Airminded. A design is submitted for a proposed airport which features recreational, as well as flying, facilities. It incorporates provision for airstrips, hangars, seaplane ramp, helicopter landing, fueling, clubhouse, automobile service station, driveways, tennis courts, baseball field, football field and bleachers, golf course, and bathhouse. *Aviation and Yachting*, December, 1945–January, 1946, pages 6, 7, 1 illus.

Heathrow Airport. A survey of Heathrow, London's new civil airport, in its existing stage of construction. While these notes are concerned mainly with a report f what has been accomplished in the way of completed runways, buildings, etc., and with an outline of some of the construction problems involved, they also give some idea of the facilities that will be provided when the entire air terminal is completed. The

transferral of the airport from the control of the Air Ministry to that of the Ministry of Civil Aviation is discussed. *Flight*, January 10, 1946, pages 37, 38, 2 illus.; "Heathrow Airport," *The Aeroplane*, January 11, 1946, pages 56–58, 5 illus.

The Irrigated Airfield. Gordon H. Jones and Major Sydney H. Watson. Details are reported about the portable irrigation system used by the U.S. Army to obtain turf capable of withstanding intensive airplane traffic in regions of low rainfall. Indicating the economic advantages of using irrigation to facilitate establishment of turf on the runways instead of providing landing areas by paving or other mechanical means, the writers describe the design and installation of the irrigation systems, relate the costs of installation and operation, and report on the effectiveness of the resulting irrigated turf.

The conclusions offered from experience with the application of the irrigation systems are: outstanding results are obtained by use of them in establishing and maintaining Bermuda grass on intensive-use areas of airfields; the costs are economical as compared to the cost of providing similar facilities by paving or other means; installation and operation are entirely practicable; and the resultant landing facility is capable of withstanding intensive use. Based on these results, it is stated that irrigation systems should be used much more extensively, in sections receiving less than 30 in. of annual rainfall, to provide dust-free landing strips for intensive use. Since the factor of soil stability during wet weather is often minor as compared to the dust factor in these regions, it is advised that the accessibility to adequate quantities of water for irrigation should always be considered in the selection of airport sites. *Southern Flight*, February, 1946, pages 50–52, 3 illus.

Armament

The Lincoln's Defence. The design, installation, and components of three types of gun turrets fitted to the Avro Lincoln are detailed. One is the Bristol B-17 Mk. I turret, used in the mid-upper position; the other two are the Boulton Paul types D and F turrets providing, respectively, the tail and nose armament.

As related, the Bristol B-17 is designed for two Mk. IV or Mk. V 20-mm. Hispano cannon with ammunition capacity of 380 rounds per gun. A Bristol all-electric drive is employed for control in azimuth and zenith, the guns also being fired electrically. Sighting is by means of a Mk. IIc gyro gun sight, and cocking and recocking is performed by compressed air.

The Boulton Paul type D turret is equipped with two 0.5-in. guns, and the type F, remotely controlled, is similarly equipped. Turret actuation in both these types is hydraulic and gun firing is electric. Electric feed assisters for the ammunition are employed in the type D turret.

In the description of the Bristol turret, particular attention is paid to details of the sighting control. In the case of the descriptions relating to the Boulton Paul turrets, emphasis is placed on the principles of the radar sighting, the actuation, and the ammunition feed. Schematic drawings depict the three turrets and their components. *Flight*, January 17, 1946, pages 62a–64, 8 illus.; "The Bristol B.17 Turret," *The Aeroplane*, January 18, 1946, pages 83, 84, 4 illus.; "The Bristol Gun Turret," *The Engineer*, January 18, 1946, pages 68, 69, 4 illus.; "Dorsal Armament," *Aircraft Production*, February, 1946, page 102, 2 illus.

Avigation

ABC's of Here-To-There. Harry G. Graybill. The private flier is advised about how to pilot his plane by means of some practical elementary navigation and meteorology. The "A-BC" rules for cross-country navigation pertain to map reading, use of the compass, and recognition of landmarks. The "ABC" for meteorology consists of adequate weather knowledge to recognize and deal with thunderstorms, icing conditions and fog, consultation with Government weather stations before starting on trips, and avoidance of exploration into unfamiliar places. *Air Facts*, March, 1946, pages 34–41.

Business and Finance

It'll Pay You to Promote Light-plane Insurance. R. L. Templeton. The first of a series of articles advising aircraft operators on the fundamental knowledge they should have in order to sell aviation insurance is concerned specifically with aircraft "hull" insurance. Explaining that this is the type of insurance which indemnifies the insured against damage to the plane, the writer outlines the need for, the advantages of, and the costs of different types of hull insurance. Three different kinds of hull policies are defined: (1) complete coverage, protecting the owner against all risks of loss including crash and fire following crash; (2) less complete coverage, protecting the owner against all risks of loss, except crash; and (3) still less complete coverage (named "Perils"), protecting the owner against usual risks to which a plane is subject while not in flight.

Besides the extent of coverage, other factors figuring in the cost of hull insurance are indicated. These include weight, whether the plane is a private or commercial one, whether it is new or used, and whether it is to be used for student instruction. The discussion also takes into consideration the meanings of deductible and participation provisions designed to impose part of the risks upon the airplane owner so that he may obtain lower rates.

The dealer or operator is advised that the best counsel he can give his patrons concerning hull insurance is: (1) buy the policy while the plane is in good shape in order to get a favorable rating; (2) if nearing 100 or 200 hours, take out the policy after passing the 100- or 200-hour marks so as to get the best participation percentage and the most protection for the money; (3) always buy the type of coverage the owner can best afford. *Aviation*, February, 1946, pages 82, 83, 2 illus.; "Don't Overlook Insurance," by R. L. Templeton, *Air News*, February, 1946, page 43.

First Step Is Choosing the Right Business Setup. Part I. Charles A. Parker. Beginning a series of articles on the efficient formation, precise systematizing, and profitable operation of an airport flying service, this installment details the factors to be considered in determining the type of organization for the enterprise. The structure, advantages, and disadvantages of three types of organizational setups—individual enterprise, partnership, and corporation—are described. *Aviation*, February, 1946, pages 84, 85.

Aviation Taxes for Airport Solvency? J. Kirk Baldwin. The enactment of aviation taxes to provide funds for the operation and maintenance of publicly owned airports is advocated. Suggested taxes for this purpose include a Federal aviation-gasoline tax; airplane-license tax; pilot's and mechanic's certificate taxes; and others. The Montana state act calling for such taxes to provide airport funds is outlined as an example of the advantages that might be derived by aviation from similar country-wide legislation.

Presently imposed state aviation-gasoline taxes are shown to be irregular in their levies and inadequate in the amounts that are used for airport purposes. A table, prepared by the Civil Aeronautics Administration, listing aviation gasoline consumption over a period of years serves as a basis for computing the amount of tax benefits that would accrue to aviation if the recommended Federal aviation-gasoline tax should be put into effect. *Airports*, February, 1946, pages 55, 56.

Our Industry's Records and Ranges. Marking the direction of future trends, tables and charts summarize the United States' aviation record before, during, and after the war. The figures show the number of aircraft units and pounds, classified into types, that were manufactured from July 1, 1940, through July 31, 1945; the numbers of airports and flying facilities developed yearly from 1927 to 1944; yearly Federal appropriations for research and development from 1915 to 1946; the numbers of workers employed in the aviation and allied industries in 1939; the number of non-scheduled commercial flight miles flown in 1939; domestic air-line traffic, capacities, and mileage during the years 1932 to 1944; the numbers of certified pilots, mechanics, and instructors there were for each of the years from 1933 through 1945; the yearly unit production of aircraft engines during the period 1917 to 1944; and the prewar output of personal aircraft from 1933 through 1941. The trend of aircraft

unit production, prewar and postwar, and the trend of aircraft certifications, prewar and postwar, are analyzed by means of two graphs. *Aviation*, February, 1946, pages 72–75, 2 illus.

So You Want to Buy an Airplane? Robert C. Hare. For the benefit of those contemplating the purchase of an airplane on a payment plan, advice is given on how to go about making the purchase and what may be expected in the way of having the transaction financed. In addition to information about methods of financing and terms, data pertaining to the following considerations are offered: eligibility for credit, availability of planes and kinds of planes, disparity in price, ownership and registration certificates, insurance, and application of veterans' loans to purchase of aircraft. The costs and payments for purchasing a typical personal airplane on a credit plan are tabulated. *Air News*, February, 1946, pages 25–27, 6 illus.

Financial Yardsticks for '46. Raymond L. Hoadley. For the benefit of aircraft-stock investors, profit possibilities of the aircraft industry for the coming year are examined. The evaluation of the industry's prospects takes into consideration actual and possible orders for military, transport, and personal aircraft. These include reference to manufacturing programs scheduled for Douglas Aircraft Company, Inc., Lockheed Aircraft Corporation, Boeing Aircraft Company, The Glenn L. Martin Company, Consolidated Vultee Aircraft Corporation, Republic Aviation Corporation, Piper Aircraft Corporation, and Curtiss-Wright Corporation. Observations are also made with regard to items affecting the trend of aircraft equities, such as manufacturers' plans for diversifying production, price trends, and export programs. Although note is taken of the general agreement by analysts that aircraft manufacturing profits for 1946 will be small, 1947 is indicated as a year that holds promise of substantial earnings for some companies. *Aviation*, February, 1946, pages 76, 77, 1 illus.

Canada's Air Industry Is Really Ready for Business. James Montagnes. An outline report is made on Canada's plans for designing, manufacturing, servicing, and selling airplanes. Noting that Canada intends to compete in international as well as domestic aviation markets, the article summarizes briefly the production programs scheduled for Canadair Ltd.; A. V. Roe Canada Ltd.; Noorduyn Aviation Ltd.; Canadian Car & Foundry Company Ltd.; Fairchild Aircraft Ltd.; The de Havilland Aircraft Company of Canada, Ltd.; Cub Aircraft of Canada; Fleet Aircraft, Ltd.; and Northwest Industries Ltd. Estimates are also made with regard to contemplated production of instruments and parts, servicing and overhauling of engines, and the conducting of engine research. *Aviation*, February, 1946, pages 78, 79, 196, 198, 3 illus.

Civil Aviation

What's Wrong with C.A.B.? John Paul Andrews. The writer criticizes the limitations imposed upon the Civil Aeronautics Board and charges that commercial aviation is being hampered by an Air Commerce Act, a Civil Aeronautics Board, and a Commerce Department's budget that were adequate for the job in 1938 but which cannot move apace with aviation's current technologic and economic advances. His chief complaints are against the restriction of air competition and, hence, of air transport, resulting from the delays in authorizing the many newly scheduled air services for which applications have been made. It is stated that the Board is handicapped by being understaffed and underfinanced and that its appropriations should be increased to provide sufficient funds to expedite its work. *Air News*, February, 1946, pages 22–24, 81, 5 illus.

Companies

T.C.A. Is Still Growing. H. J. Symington. The President of Trans-Canada Air Lines records the history of the company's operations during 1945 and outlines some of its plans for 1946. His report tells of the expansion of services and routes; the amount of passenger, express, and mail traffic carried; the acquisition of new equipment; innovations in the communications systems; continuation of specified domestic and international routes; and the increase of the company's staff. *Commercial Aviation*, January, 1946, pages 55, 56, 2 illus.

Control Equipment

A New Servomechanism Theory: The Synthesis of Automatic-Control Systems. W. C. Robinette. The writer discusses in detail his new theory of servomechanical control that follows empirical procedure. It is stated that it was the attainment of certain performance characteristics in the laboratory which led to a design of servomechanisms with the entire range of the dynamic and static variables adjustable by simple mechanical manipulations and that this adjustability is the basis of the theory. Sections of the article deal with the nature of the theory; the characteristics of the system selected as a first example; applications, instructions, and the characteristic curve; and the application of the theory to the synthesis of "high-performance" servomechanisms. *Instruments*, February, 1946, pages 74–81, 7 illus.

Deicing

Reduction of the Adhesion of Ice to De-Icer Surfaces. D. L. Loughborough and E. G. Haas. Ice is removed from a deicer surface by mechanically applying concentrated stresses to the ice-rubber interface. It is obvious that a low value for the adhesive bond should be desirable, but it is conceivable that a zero value might not be practical. The shear strength of the bond to the deicer surface is as high as that between ice and any other solid; it increases linearly with decrease in temperature from a value of zero at 0°C. to 150 lbs. per sq.in. or more at −25°C. It is approximately 15 per cent higher to the surface of a rubber that has soaked in water and probably depends on surface smoothness only to the extent that a rough surface presents a greater area.

It has been found that silicone, either formed *in situ* by polymerization on the deicer surface or applied as ready-made polymer, improves the performance of deicers by lowering the adhesion of ice to the surface by as much as 90 per cent. These treatments have shown good results both in the laboratory and in flight tests. It is expected that, because of the toughness of the films formed by silicones, they will need to be applied only a few times during an icing season. *Journal of the Aeronautical Sciences*, March, 1946, pages 126–134, 9 illus.

Design

The Twin Engined Personal Plane. Richard G. Naugle. After outlining the advantages of the twin-engined type of airplane as a small general-utility transport for personal and commercial use, the writer examines the difficulties involved in designing such a plane. Taking the classic arrangement of the low-wing, tricycle-geared type as exemplified by several military versions, he outlines the problems encountered in adapting the design to commercial service. These include access to the cabin; vision range of the pilot and passengers; center-of-gravity location with its attendant effects on stability; and the design and production problems of wing form, engine and propeller location, and landing-gear layout. An arrangement regarded as feasible is suggested, providing seats for the pilot and copilot forward of the propellers, passenger seats aft, and engines of the opposed-cyclinder type "buried" in the wing with propellers mounted on short extended shafts. It is stated that the design would represent the best obtainable aerodynamic efficiency but would entail increased weight and cost. Although satisfactory for cross-country transportation of passengers, it would have limitations as a "jack-of-all-trades" type of plane. A future article will consider the possibilities of the high-wing, twin-engined, pusher-type airplane. *Western Flying*, February, 1946, pages 28, 29, 48, 50, 52, 7 illus.

Triple-alloy steels containing Nickel offer designers the following *triple* advantages:

1. OUTSTANDING PERFORMANCE—Strength and toughness, resistance to wear, fatigue or shock to meet a wide range of requirements, as dictated by design.
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Cockpit Development. John A. Sizer. The writer reviews the development of the cockpit and its equipment and discusses present-day designs. Cockpit designs used on many of the early type of airplanes are described and illustrated. The development of enclosed cockpits and the evolution of the control column and other aircraft controls are traced. An outline of lighting developments is included. *Aeronautics*, February, 1946, pages 72, 75, 76, 78, 81, 82, 85, 13 illus.

Air Tech Presents the Republic Seabee. Design, engineering, construction, and operational features of the Republic RC-3 Seabee amphibian are reviewed. Illustrated by photographs and drawings, the article surveys details of the plane under the following component parts: hull assembly; wing assembly; tail assembly; and cabin assembly. *Air News*, February, 1946, pages 53–57, 16 illus.

Flapping Wings. William B. Stout. The head of the Stout Research Division of Consolidated Vultee Aircraft Corporation explains why he believes that the insect may be the pattern for a new application of the flapping-wing principle in aircraft design. What can be learned from a study of insect flight is discussed, and suggestions for a scientific approach to the subject are made. Diagrams and a photograph of a cicada in flight clarify the text. *National Aeronautics*, February, 1946, pages 12–14, 2 illus.

Under-the-Wing Refueling. C. Stewart Brandt. Citing the advantages of "under-the-wing" refueling techniques as opposed to the inadequacies of "over-the-wing" methods, the writer explores the design problems facing the aircraft manufacturer if the former system of fuel servicing is to be made standard. Among others, he discusses in detail considerations of weight, equipment changes, filler location, fuel trapped in a pressure type of refueling system, and controlled filling, which must be taken into account. Advantages listed for the "under-the-wing" means of refueling are: (1) Fire hazards can be almost completely eliminated, provided the part of the system installed in the airplane is of the closed type; (2) with proper design, both in the airplane and airport installations, it will be possible to refuel multitank aircraft with a bare minimum of equipment and man power; (3) provided pressure heads and line velocities are kept low, delivery rates can be increased to such an extent that refueling will consume only a fraction of the scheduled stop time; (4) wing damage will be eliminated; (5) equipment congestion will be eliminated; (6) tank-filler fittings can be located in the best and most convenient places; and (7) the necessity of walking on the wings will be eliminated as far as filling the tanks is concerned, hence, accident rates will be materially reduced. *Aero Digest*, February, 1946, pages 74–76, 95, 97, 7 illus.

Southern Aircraft's experimental automobile-type airplane. The wings, propeller, and tail section can be removed to convert the roadable unit to a conventional-type automobile.

Commercial Avenger. T/Sgt. Bob Davis. The potentialities of the Grumman Avenger, if used as a cargo-passenger transport plane, are envisioned. An outline is also given of the modifications that would be necessary to convert this torpedo bomber into a transport. Although the Avenger is acknowledged as having only limited capacities for carrying passengers and cargo even in its converted state, its transport possibilities are compared favorably with those of an R4D or Skytrain. *Air News*, February, 1946, pages 74, 75, 4 illus.

Design for Profit. Part II. H. G. Lesley. Part two of a series in which means of redesigning transport aircraft to speed maintenance operations are studied. Changes in the design of the power plant and accessories which will make possible faster and more efficient maintenance are considered. The writer discusses the advantages of interchangeable engines and considers improvements in the design of cowl flaps, air scoops, and other parts which will facilitate maintenance operations. *Air Transport*, February, 1946, pages 49, 50, 52, 55, 5 illus.

The Flying Automobile. Edward Churchill. Background information is provided with regard to the evolution of the "flying automobile" prototype developed by Southern Aircraft. Although the airplane is reported to incorporate changes not yet revealed, the article contains a general discussion of the reasons for, and the methods of, developing several of its features. These features include tubular steel spars in the construction of wing, booms, and empennage; full-span ailerons; wheel-assisted take-off; location of booms at the wing root; and twin vertical tails. *Southern Flight*, February, 1946, pages 28–30, 2 illus.

Missing Links. Martin Caidin. One of a series of articles tracing the design evolution of the American fighter plane. In this installment design and operational features of the following types are investigated: Lockheed P-38M Night Lightning; Lockheed "Droopsnoot" (described as a revamped P-38J-20-LO or P-38L-5-LO); Lockheed P-38J-15-LO Pathfinder; Lockheed Swordfish; Lockheed XP-49; Lockheed XP-58 Chain Lightning; Curtiss XP-40Q; Curtiss XP-60 series; Curtiss XP-62; Curtiss XF14C-2; Curtiss XF15C-1; Republic XP-47J; Republic XP-72; North American XP-78; North American P-82 Twin Mustang; Northrop XP-79; Consolidated Vultee XP-81; Bell XP-83; Goodyear F2G-1; and Boeing XF8B-1. Other American fighter planes are mentioned. *Air News*, February, 1946, pages 30–33, 78, 23 illus.

Wanted . . . A Flying Oxcart. Ted Fithian. Indicating the need for and the marketability of such an aircraft, the writer urges United States airplane manufacturers to develop a plane specifically designed for hauling freight on short trips over the Andes country in Central and South America. He also outlines specifications for the type of "flying oxcart" that is required. It is stated that this plane should include radar devices, superchargers, deicers, isolation and oxygen equipment; should be slow in landing and quick in take-off; need only have a fuel capacity for 300 miles; should have a comparatively low flying speed, sacrificed to greater pay load. *Skyways*, March, 1946, pages 20, 21, 56, 58, 5 illus.

Education

More About Less. Edgar S. Fuller. A picture is drawn of the aeronautical aspects of the education programs that are being carried out in junior colleges, colleges, and universities in various parts of the United States. The Civil Pilot Training and War Training Service programs are credited with having established the foundations for a large proportion of the current activity in aviation education. The courses of-

fered by various colleges are outlined briefly. It is urged that the colleges give more consideration to the value of aviation education. *National Aeronautics*, February, 1946, pages 15, 16, 1 illus.

Electrical Equipment

Electrical Measurements on Aircraft-Engine Ignition Circuits. William E. Berkey. A method of measuring voltages in aircraft-engine ignition circuits with a cathode-ray oscillograph is described. Typical oscillograms are shown which explain the operation of an ignition system used on a high-power aircraft engine. Magneto and spark-plug voltage oscillograms covering several consecutive firing pulses were taken on a complete aircraft magneto ignition system under several engine-operating conditions. Oscillograms taken with spark plugs firing in air showed differences when compared with engine tests. It is stated that the importance of complete radio shielding and adequate electrical insulation becomes apparent with increased knowledge of ignition voltages and currents. An electronic oscillograph especially developed for ignition circuits is described briefly. *Electrical Engineering*, February, 1946, pages 49–53 (Transactions), 9 illus.

Pressure-Arc-Interruption Circuit Breakers for 400-Cycle Aircraft Electric-Power System. B. O. Austin. The writer describes pressure-arc-interruption circuit breakers that have been developed for the 400-cycle electric power systems of large aircraft. Design problems connected with producing such a circuit breaker are discussed. The construction of the circuit breaker is described. Curves show its operating characteristics. It is stated that the device functions much the same as a circuit breaker for industrial systems, but its weight is only a small fraction of an industrial circuit breaker's weight. *Electrical Engineering*, February, 1946, pages 58–60 (Transactions), 10 illus.

Effect of Altitude on Ventilation and Rating of Aircraft Electric Machines. Cyril G. Veinott. Fundamental problems involved in the cooling and rating of aircraft electric machinery at medium and high altitudes are studied. The paper was written to assist users in the application of such equipment and to assist builders in designing equipment to meet the requirements. In addition, flight tests are reported which confirm in part of the blast-tube theory developed in a previous paper. An equation is developed for blast-cooled generators to show the maximum permissible output in terms of entering-air temperature and density, ramming-head pressure, and winding temperature. For motors, curves of total winding temperature at rated load are plotted as a function of altitude; these curves are plotted for selected values of sea-level temperature rise. Specific conclusions are drawn as to: (1) permissible generator output as a function of altitude and sea-level temperature rise; (2) limiting sea-level temperature rises for motors on the basis of constant or reduced life at altitude. The paper presents a qualitative method of analysis rather than a definitive solution of the problems involved. *Electrical Engineering*, February, 1946, pages 84–90 (Transactions), 10 illus.

Engines

Effect of Engine Exhaust Pressure on Performance of Compressor-Engine-Turbine Units. C. Fayette Taylor. The writer reports the results of work carried on to determine the effect of variations in engine exhaust pressure on the performance at various altitudes of compressor-engine-turbine combinations for aircraft in which the turbine is geared to the engine crankshaft. Measurements were made of indicated mean effective pressure, fuel consumption, and exhaust temperature on a liquid-cooled aircraft-engine cylinder at various inlet and exhaust pressures. Experiments were also conducted to determine the ratio of engine exhaust pressure to engine inlet pressure required for maximum net output and for lowest net fuel consumption. It is concluded that the combination unit can give high specific output and low specific fuel consumption, particularly at high altitudes. Exhaust pressures do not appear to impose undue mechanical or thermal stresses on the engine. *S.A.E. Journal*, February, 1946, pages 64–73 (Transactions), 12 illus.

The Practicability of Vibration Control in Light Aircraft. Dwight C. Kennard, Jr. The approach of the Air Technical Service Command to the problem of developing and evaluating a new engine-mount design is outlined. Included are a description of instrumentation, methods of vibration analysis, and a presentation of natural-frequency formulas for elastically mounted power plants. The results of flight-vibration tests are presented for the standard engine mount and an improved experimental engine mount installed in the North American AT-6C airplane. The test results show that the experimental engine mount, by providing natural frequencies of the mounted power plant which fall within the frequency range specified by the Air Technical Service Command, reduces appreciably the vibration of the engine and airplane structure. *Transactions of the A.S.M.E.*, February, 1946, pages 81–88, 12 illus.

Rolls-Royce Griffon 130. Design, construction, and performance characteristics of the Rolls-Royce Griffon 130 aircraft engine are examined. It is reported that this new version of the Griffon, although basically similar to the Griffon 65, differs from its predecessor in having a three-speed, two-stage supercharger and a Rolls-Royce fuel-injection system to replace the Bendix-Stromberg wartime installation. These innovations enable the 130 to develop over 2,000 b.hp. at 20,000 ft.

Among other features of the engine noted are the change-speed mechanism, the new fuel-metering pump, and the oil-control valves. Installation clearances remain unchanged. In analyzing the advantages that have been gained with modifications incorporated in the 130, the article offers a comparison of the combat rating power curves for the three-speed Griffon with those of the earlier two-speed models. *Flight*, January 10, 1946, pages 34–36, 38, 5 illus.; "Rolls-Royce Supercharging Developments," *The Aeroplane*, January 11, 1946, pages 45–47, 5 illus.; "The Rolls-Royce 'Griffon' 130 Aero-Engine," *The Engineer*, January 25, 1946, pages 77–79, 4 illus.; "The Rolls-Royce 'Griffon' Aero Engine," *Engineering*, February 8, 1946, pages 128–130, 8 illus.; "Rolls-Royce Griffon 130," *Aircraft Production*, February, 1946, page 73, 1 illus.

Photograph Courtesy Greer Hydraulics, Inc.

The use of lightweight metals, simplified design, and precision machinery have made possible production of a new poppet-type check valve. The valve is reported to have completed a 50,000-cycle test, fully open to fully closed, at 2,000 lbs. per sq.in., without appreciable wear on either the poppet or the seat. The unit is composed of a valve housing, a hollow aluminum-alloy poppet and guide, a valve spring, and a retaining ring.

The Engine in Your Plane. Nathaniel F. Silsbee. A review of the engines powering 1946 personal aircraft and of the development trends in these engines. Engines mentioned include those manufactured by Continental Aviation & Engineering Corporation, Aircooled Motors Corporation (Franklin engines), Lycoming Division, of The Aviation Corporation, Ranger Aircraft Engines Division of Fairchild Engine & Airplane Corporation, Warner Aircraft Corporation, General Motors Corporation, Diesel Power, Inc. Supplemented by comments about the airplanes they power, leading contenders in the light-plane engine field are depicted. *Skyways*, March, 1946, pages 26, 27, 72, 74, 17 illus.

How to Service Rocker Arm Bearings. A brief article explains the proper way to service aircraft-engine valve rocker-arm bearings. A step-by-step description of the various operations is included. *Aviation Service Magazine*, February, 1946, pages 26–29, 11 illus.

Aviation Gas Turbine Installation Problems. M. C. Benedict. The article has reference to problems that are likely to be encountered when installing turbojet engines in very high-speed aircraft. The writer first considers the problem of coordinating the design of the engine air inlet duct so as to bring the air to the engine inlet with minimum loss in total pressure and maintain even distribution across the face of the engine inlet. He then discusses engine suspension, the engine fuel and lubricating systems, the instrumentation necessary to check proper engine operation, cooling of the engine accessories, and the turbojet engine control system. Problems involved in turbine-propeller engine installations are also mentioned. *S.A.E. Journal*, February, 1946, pages 88–92 (Transactions), 10 illus.

Pressure Air Cooling Technique. G. E. Lind Walker. Part I of a two-part article in which the writer formulates a general picture of the whole operation of engine cooling, surveys present knowledge regarding "pressure air cooling," and outlines a program for future research. It is stated that "pressure air cooling" promises an appreciable gain in all-round performance. After defining the terms used in the text, the writer discusses sources of waste heat in the engine, the ducted cooling system, the "pressure air-cooling" system, and internal flow conditions. *Aircraft Engineering*, January, 1946, pages 2–7, 17, 16 illus.

Rolls-Royce Griffon 65. Part I. J. A. Oates. Part one in a series of articles on the fabrication and assembly procedures involved in the manufacture of the Rolls Royce Griffon 65 aircraft engine reveals the features of the engine's design. It gives in considerable detail the sequence of operations connected with matching the forked connecting rods. The remainder of the current installment reviews some of the more important of the 112 operations included in producing the crankshaft and describes some of the major equipment utilized in the procedures.

Particulars are presented under the following headings: crankcase and cylinders; ignition system; the supercharger; the forked connecting rod; location surfaces; profiling; machining and finishing the channel; milling or gashing gap in the fork; final group; drilling the bolt holes; boring the big end; inspection and assembly. Other topical headings are the crankshaft, the driving cradle, boring the pins and journals, finish-boring, profiling the webs, and drilling the webs. The 58 machining operations employed for the forked connecting rod and the 112 used on the crankshaft are listed in two tabulations. Included in the numerous illustrations is a full-page schematic drawing of the complete twelve-cylinder engine. *Aircraft Production*, February, 1946, pages 58–73, 37 illus.

The irregularity of receipt of publications from abroad necessitates the review of articles in issues several months late. This is done to provide readers with information regarding foreign technical progress as soon as the issues are available in the United States.

Induced Air Flow for Engine Cooling. The phenomenon known as the "induced flow effect" is discussed, and the possibility of using this principle to increase airflow in engine-cooling systems and as a thrust augmentor in jet engines is considered. Henry Coanda, a Roumanian engineer, has been investigating the theory that concerns the flow of fluids through special nozzles. The article was prepared from a report titled "The Coanda Effect," which was compiled by power-plant engineers of the British Ministry of Aircraft Production and the U.S. Navy. The information was obtained by interrogation of Henri Coanda and members of his laboratory. It is stated that by means of a venturi and special slots, an induced flow six to 20 times that of the working fluid has been established. The theory and operation of the nozzles is described in detail. *Automotive and Aviation Industries*, February 15, 1946, pages 30, 31, 108, 4 illus.

Rolls-Royce Merlin 130 Series. The article deals with the installation of the Merlin 130 and 131 engines in the de Havilland Hornet. Besides relating details of the engines' design, construction, and performance, it also traces the development of these power plants for the particular adaptation, tells how the 130 and 131 were altered from their predecessor types to suit the needs of the Hornet, and indicates the advantages that were derived from fitting the two engines to the fighter. Among features of the Hornet Merlin installation noted in the article are those relative to the ducted air intakes, low-pressure fuel-injection systems, exhaust systems, bearings, superchargers, and methods of lubrication.

The Hornet Merlin installation is cited as representing a pioneer attempt to design a production engine into a power plant, in contradistinction to designing the power plant around the engine. It is explained that the 130 is a right-hand tractor unit for the port side of the airplane, while the 131 is a left-hand tractor for the starboard nacelle. Performance figures for the Merlin 130 series are listed and various illustrations depict the design details. *Flight*, January, 24, 1946, pages 92–94, 96, 6 illus.; "Power Plants for the Hornet," *The Aeroplane*, January 25, 1946, pages 105, 106, 4 illus.

Gas-Turbine Fundamentals. Dale D. Streid. The theory and performance of gas turbines are discussed with particular reference to what is termed the "dynamic" type, used for aircraft applications, in which the performance is greatly affected by the forward speed of the aircraft. Calculations of the performance of different kinds of gas turbines are set forth. Tables give the standard efficiencies and constant values for gas turbine calculations, and curves show the effects of various factors on gas turbine performance. Diagrams illustrate the principles on which the different forms of gas turbines operate. *Mechanical Engineering*, February, 1946, pages 127–133, 16 illus.

Maintenance of Fuel and Carburetion Systems. Gilbert C. Close. Supplemented by advice on how to avoid the inadequacies by correct maintenance procedures, this is an investigation of the origin of some of the more common troubles that occur in aircraft carburetion and fuel systems. The trouble sources are divided into three general classifications: (1) lack of pilot familiarity with the fuel system of the airplane he is flying; (2) exceeding operational limits of the engine; and (3) conditions encountered during flight. Among the problems noted particularly are those connected with improper control of flow rate and fuel mixtures, carburetor icing, continuous detonation, and preignition. A table serves as a guide to locating the possible causes of trouble classified under headings of rich mixture, lean mixture, vapor lock, excessive fuel consumption, and air leaks. The table also indicates which of these troubles require the attention of a competent mechanic and which can be corrected by the pilot himself. *Western Flying*, February, 1946, pages 38, 39, 52, 1 illus.

Aircraft Engine Ignition Timing. A brief article explains why the dual magnetos on many aircraft engines are not timed for simultaneous sparking. The writer describes how the relative amount of spark advance for the two magnetos is determined by operating one magneto at a time. Charts give the ignition specifications of the Allison

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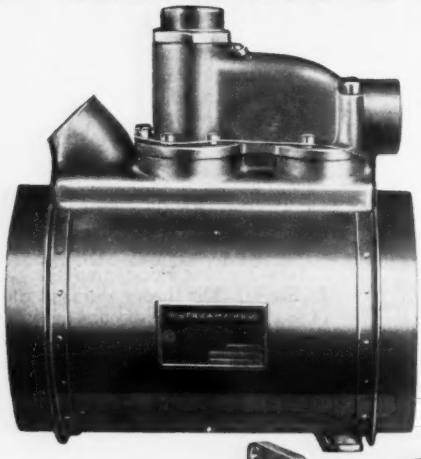
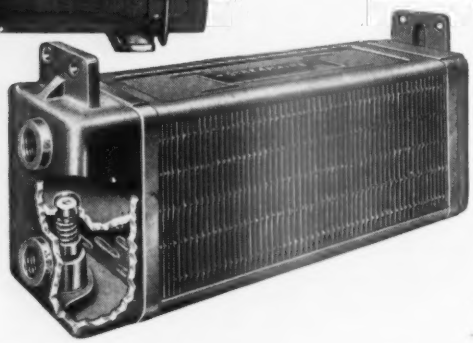


Left: Young STREAMAIRE Oil Temperature Regulator, consisting of new jacketless lightweight type oil cooler, with internal oil passages to provide anti-congealing and warm-up performance, equipped with thermostatic oil temperature control and relief valve. Available in 4" to 9" diameters inclusive, and with 15 or 30 lb. spring loaded relief valve.



Right: Young Rectangular type Oil Temperature Regulator with integral temperature control and relief valve, thermostatic or spring type, for light plane installation. Tube-and-fin type core, with internal warm-up passages for thaw-out, gives excellent heat transfer with low air velocity.

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V-1710 engine and the Wright Cyclone R-1820 engine. *Aviation Service Magazine*, February, 1946, pages 18, 19, 2 illus.

The "Sabre" Aero Engine. After a brief review of the various steps in the development of the Napier "Sabre," the writer gives details about the Series VA engine. Design and performance data on the latest version of this 24-cylinder H-type, sleeve-valve engine are included. It has a weight of 2,460 lbs. and is stated to develop 2,600 b.hp., which makes the power-weight ratio 0.94. *Engineering*, January 25, 1946, pages 79–81, 4 illus.

Cruising Economy by Use of Water Injection. D. C. Eaton. The paper gives details about an investigation of the benefits the aircraft operator may gain from the use of water injection as a means of assisting engine cooling and increasing detonation-limited powers. A cost analysis is made of three methods of increasing airplane performance by water injection. These include increasing the performance by (1) increasing cruising brake mean effective pressures while maintaining engine cooling requirements at the value for conventional cruising brake mean effective pressures; (2) decreasing cruise power cooling requirements with the addition of water; and (3) increasing cruise powers up to estimated take-off at a constant fuel-air ratio while maintaining low cooling requirements and avoiding detonation with the use of water. It is concluded that, if the water to be used for cooling does not displace an equivalent weight of pay load, a maximum saving of 7 per cent at sea level and 18 per cent at 25,000 ft. can be realized in direct operating cost by the use of water. At the same operating cost a performance increase of 3 per cent at sea level and 12 per cent at 25,000 ft. can be realized. However, if the water carried results in an equivalent loss in pay load, the operating cost may be doubled if water injection is used. *S.A.E. Journal*, February, 1946, pages 81–87, 92 (Transactions), 12 illus.

The Junkers Jumo 004 Jet Engine. The second and concluding installment of an article describing design features of the German Jumo 004 jet engine, as disclosed by a critical examination of the power plant. The writer discusses the design of the main fuel system, starting system, and lubrication system. Material analyses and performance results are included. *Aircraft Engineering*, January, 1946, pages 10–14, 17, 9 illus.

Flight Operations

ETA—Minus E. Scholer Bangs. A description of methods that enable the Naval Air Transport Command consistently to land its Douglas four-engined transports within 18 min. of the forecast time of arrival on the longest ocean route now in operation. It is suggested that these methods will provide hints for global commercial

Consolidated Vultee Aircraft Corporation's radio-controlled free-flight model airplane. Three persons are required to start the midget engines. One controls switches on the battery box, another spins the propeller, while the third adjusts the engine.

carriers. The writer discusses important features of the Command's "Positive Flight Control" system. *Air Transport*, February, 1946, pages 29–34, 11 illus.

Flight Technique

Altitude and Take-Off. Lawrence Keil. A study of the effect of various altitude and temperature changes upon a plane's standard performance. From data compiled by the Flight Engineering and Factory Inspection Division of the C.A.A., simplified tables are shown which enable a pilot to determine performance characteristics of his airplane at a given altitude and specific temperature. Values of importance which are discussed include the take-off run, the rate of climb for the first minute, and the stalling speed. In order that the chart may be fully interpreted, the relationship of "standard atmosphere" to an altimeter is explained as a prerequisite to an understanding of lift, air speed, and altitude. The purpose and operating principles of the air-speed indicator are defined. *Flying*, March, 1946, pages 54, 55, 96, 97, 1 illus.

Flying the Beech. A. H. Knouff. An appraisal of the flying and handling characteristics of the Beechcraft GB-2 single-engined airplane. Pointers in connection with the landing gear, comments about the forward vision range, and the fuel system are featured in the report. *Southern Flight*, February, 1946, pages 38, 39, 1 illus.

Fly One—Fly All. Capt. C. Trumbull, Jr. Contrary to opinions that the transition from flying one type of plane to another is difficult, it is the writer's contention that if a pilot can ably fly one type of airplane he can quickly learn to handle any type. He relates his experiences in accustoming himself to piloting diversified types of planes while ferrying aircraft for the British. The only general prerequisites stated as necessary for a pilot to fly all types of planes are that he have a fair understanding of simple aerodynamics, a familiarity with mechanics of airframes and engines, a commercial license, and a sincere interest in flying.

A system taught by the British is said to permit the pilot to check out in many different types of aircraft in rapid-fire order. This scheme is outlined, and it is the writer's belief that it will be adequate for any current model of airplane with a few minor variations. *Flying*, March, 1946, pages 63, 86, 88, 1 illus.

The New Ercoupe. Leighton Collins. Although some comments are made about the design, construction, and cost of the plane, the major portion of this article on the latest model Ercoupe is concerned with an account of the aircraft's flying and handling characteristics. The airplane's qualities and responses are analyzed through the successive phases of warming up, starting, take-off, climb, level flight, turns, power and other stalls, gliding, descent, approach for landing, and landing (including cross-wind conditions). Details relative to the Ercoupe's speeds, noise level, and safety features are included. *Air Facts*, March, 1946, pages 11–31, 5 illus.

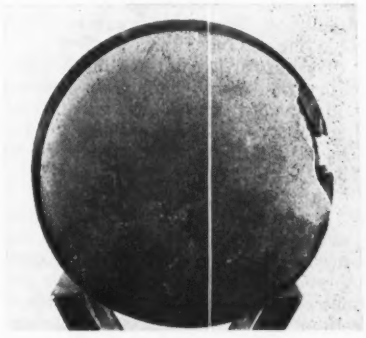
Why Fly Patterns? John R. Hoyt. The practice of studying precise patterns in flight training is justified. Reasons for flight patterns are summarized under the following four points: (1) They permit an instructor to test his student; (2) they establish a routine by which a student can practice and test himself; (3) they furnish a problem from which there is transfer of knowledge to other problems, such as drift, completing turns early instead of late, holding altitude, etc.; (4) they standardize procedure, flight check, practice hours and make for a high level of performance. Two kinds of patterns are defined—pattern on the ground and pattern in the sky, or the path traced by the nose of the plane. The article also lists and describes maneuvers in which pattern is a factor that makes for the success of the maneuver. In approximate order of increasing technical difficulty, this list includes the following: (1) rectangular course around a field; (2) landings; (3) spirals; (4) "S" turns across a road; (5) pylon eights around a pylon; (6) spot landings; (7) emergency landings; and (8) lazy eights. *Flying*, March, 1946, pages 61, 108, 109, 2 illus.

Flying the Airspeed Oxford. Preceded by a general description of the Airspeed Oxford and its development, techniques are advised for preflight checking and for handling the Oxford in flight. Flying characteristics of the airplane are described, and a summarizing evaluation is given of the plane's merits and faults. The various cockpit controls are identified by means of a diagrammatic layout. *The Aeroplane*, January 25, 1946, pages 112–114, 9 illus.

Fuels

A Petroleum Engineer Looks at Aircraft Fuels. A. G. Cattaneo, F. G. Bollo, and A. L. Stanly. The problem of producing good blended aircraft fuels from the hundreds of components now available to the refiner is discussed. To accomplish this it is stated that the aircraft and oil industries must cooperate in determining actual fuel-performance requirements. An analysis is made of the factors affecting the fuel-engine combination. These include power, economy, and reliability, including safety. Both reciprocating engines and gas-turbine engines are considered. *S.A.E. Journal*, February, 1946, pages 55–63 (Transactions), 15 illus.

Gas Up Your Plane. Robert C. Franklin. Certain fundamental factors regarding aviation gasoline are examined. Noting performance characteristics that make aviation gasoline a distinctive fuel, the writer defines the nature and action of such phenomena as detonation and vapor lock. He also explains what "octane" means, the grade numbers in classifying aviation gasoline,



Photograph Courtesy Shell Oil Company, Inc

An example of preignition failure on a supercharged CFR engine aluminum piston.

and what is meant by "low-volatility fuel." The possible replacement of aviation gasoline by fuels suitable for Diesel and gas-turbine engines is mentioned. *Skyways*, March, 1946, pages 52, 53, 92, 94, 2 illus.

Gliding and Soaring

Target Gliders. J. R. Vanderbeck. This article deals with the design, construction, and operation of model gliders used by the British for target practice in the training of light antiaircraft gunners. The equipment detailed includes the 6 ft. 3 in. "Free Flying Glider Mk. 1"; the "RG," a rocket-propelled glider having twice the speed and range of the Free Flying Glider, having the ability to fly well in rough weather and to be operated from restricted spaces because of its catapult take-off; the launching catapult for the "RG"; 16-ft. aircraft-towed pilotless gliders; and towed gliders of 32-ft. span. *The Aeroplane*, February 1, 1946, pages 131–133, 7 illus.

Aerodynamics of Glider Flight. Part II. W. Z. Stepniewski. The first part of this serial article, appearing in *Aero Digest* for October 1, 1945 (reviewed in the AERONAUTICAL ENGINEERING REVIEW, December, 1945, page 69), dealt with problems of straight flight, and the importance of different design parameters was discussed with reference to various flying conditions. The current installment deals with turning flight and the performance of the controls of a glider, the most important problem being the rolling motion caused by the rolling action of the ailerons. The calculation of the rolling moment is explained, and specific examples are worked out for the rolling-moment coefficient and the damping coefficient. The functions of lift-increasing devices are considered, and the relationship between minimum sinking speed in a turn and other parameters is established. An equation is developed for computing the minimum sinking speed when a steady turn of a given radius is performed, which can be used in preparing a graph showing the best flying speeds for a given glider as a function of the radius of turn. Fowler flaps and slotted flaps are mentioned as a means for increasing the lift coefficient with as small an increase as possible in the profile drag.

The next article in the series will deal with wing aerodynamics in general, and some of the problems of lift-increasing devices will be discussed. *Aero Digest*, February, 1946, pages 58–60, 150, 153, 154, 10 illus.

The Evolution of the Sailplane. J. A. Simpson. Past, present, and future developments in the design, performance and use of sailplanes are discussed. A review of past achievements is presented in graphic form. Methods of estimating the efficiency of sailplanes are described, and a chart shows the trend of sailplane performance. Sixteen types of gliders are illustrated and their characteristics are discussed. A table gives the principal characteristics

of record-breaking sailplanes. Other charts show the trends of aerodynamic loading; wing area, weight, and parasite area; span, cantilever ratio, and aspect ratio; and wing-section thickness and camber. *Aeronautics*, February, 1946, pages 28–33, 32 illus.

Introducing—Gliders and Sailplanes. Peter F. Murray. The article contains brief descriptions of some of the gliders and sailplanes used before the outbreak of European hostilities in 1939. It is stated that a recent survey of the gliders and sailplanes in use throughout the world between 1930 and the outbreak of war showed that at least 300 basic types of unpowered aircraft were designed and flown during that period. The notes give details of a small selection of types as examples of the gliders and sailplanes in their particular classes. Tables contain data on single-seat primary and secondary gliders, single-seat high-performance sailplanes, two-seat gliders, unconventional gliders and sailplanes, and postwar British types. *The Aeroplane Spotter*, February 7, 1946, pages 30–32, 15 illus.

The Case for the Single-Place Training Glider in the Public Schools. Wesley B. Hammond. In a paper presented at the 1945 Motorless Flight Conference, the single-place utility glider is advocated for New York State public school glider-training courses. Reasons why the writer believes this type of glider is most suitable for the purpose are set forth. *Soaring*, January-February, 1946, pages 14, 15, 2 illus.

Gliding Is Sport. Alexis Dawydoff. How the advancement of gliding as a sports medium has contributed to the science of aviation is shown. The history of gliding in the United States is outlined briefly through its prewar and war phases, while prospects for the future are also considered. In addition, arguments are offered in favor of the functional value of gliding as a medium for the improvement of piloting technique and as an impetus to the development of aeronautical science. *Skyways*, March, 1946, pages 30–33, 78, 99, 100, 6 illus.

Design Diving Speed of Gliders. W. Z. Stepniewski. A paper that was prepared in conjunction with work on the design requirements for gliders carried out by the Soaring Association of Canada. It deals with the evaluation of the design diving speed of gliders on the basis of the allowable time of vertical diving or the allowable altitude lost in a dive. The main purpose of the paper is to present a new approach to the problem of evaluation of the design diving speed for gliders, rather than to give final curves for immediate use of the designer. *Soaring*, January-February, 1946, pages 10–12, 4 illus.

Streaming and Winching. An account is given of the two major operations in the handling of 16-ft. and 32-ft. pilotless towed gliders used as targets for the training of British antiaircraft gunners. The first operation is streaming, which consists of the lengthening of the tow after the tug and target are air-borne. Winching, the second operation, covers the reverse procedure before landing. Men responsible for most of the experimental flying of these target gliders are named and accredited. *The Aeroplane*, February 1, 1946, page 136, 1 illus.

History

A Chronology of The Royal Aeronautical Society. The January issue of *The Journal of The Royal Aeronautical Society* is a special number commemorating the 80th anniversary of the Society. The first 19 pages contain a message from the President of the Society, Sir Frederick Handley Page; a reproduction from the first annual report of the list of members of the first Council; a picture of the Duke of Argyll, who was the first President; and a chronology of The Royal Aeronautical Society from 1866 to 1946. Charts showing the growth of the membership of the Society, world's air-speed records, altitude records, and distance records are included.

A separate booklet of 56 pages, titled *Eighty Years of British Aviation*, reviews the work of The Royal Aeronautical Society from January 12, 1866, to January 12, 1946. It relates the history of the Society from the first meeting held at Argyll Lodge by the committee, consisting of The Duke of Argyll, James Glaisher, Fred W. Brearey, F. H. Wenham, Dr. Hugh H. Diamond, and James William Butler. Biographic sketches of each of these founders contain brief notes of their achievements, after which important events in the history of the Society are recounted, with quotations from the minutes of various meetings, from annual reports, and from statements of numerous famous scientists who were members. Excerpts from important papers presented at meetings of the Society are included, as well as reproductions of documents of the Society, pictures of its past presidents, and brief sketches of their careers. The booklet relates the participation of the Society in the development of the aeronautical sciences and of the aviation industry, with pictures of early aircraft, of exhibits of the Society at aeronautical expositions, and of the Society's headquarters. It concludes with a summary stating that during the past 80 years, a total of 684 lectures has been given, 559 meetings of the Council have been held. It is reported that the Society now has 24 branches.

The inside back cover contains a list of all of the presidents and secretaries of the Society and their terms of office. *The Journal of The Royal Aeronautical Society*, January, 1946.

Inspection

Metallographic Examination Discloses Causes of Machining Difficulties. N. R. Cusworth, J. W. Caum, and S. S. Kingsbury. A description of tests that have revealed the reasons why tools became dull on runs with well-tried setups. Micrographic examinations disclosed that alloy variations were responsible for the difficulty. Photomicrographs show the structure of nonferrous casting materials. *Materials & Methods*, February, 1946, pages 434–437, 10 illus.

X-Ray as a Foundry Control Tool. George Mullowney. The writer outlines the advantages of X-ray inspection as a means of guiding the application of corrective procedures in the foundry, reducing operational costs, and ensuring the constant production of a sound product. Problems encountered in the work are reviewed, and the machines used are described. Tabulations list the defects and their causes, and cost estimates are included. Radiographs show the most common defects found in magnesium castings. *Aluminum and Magnesium*, February, 1946, pages 18–21, 3 illus.

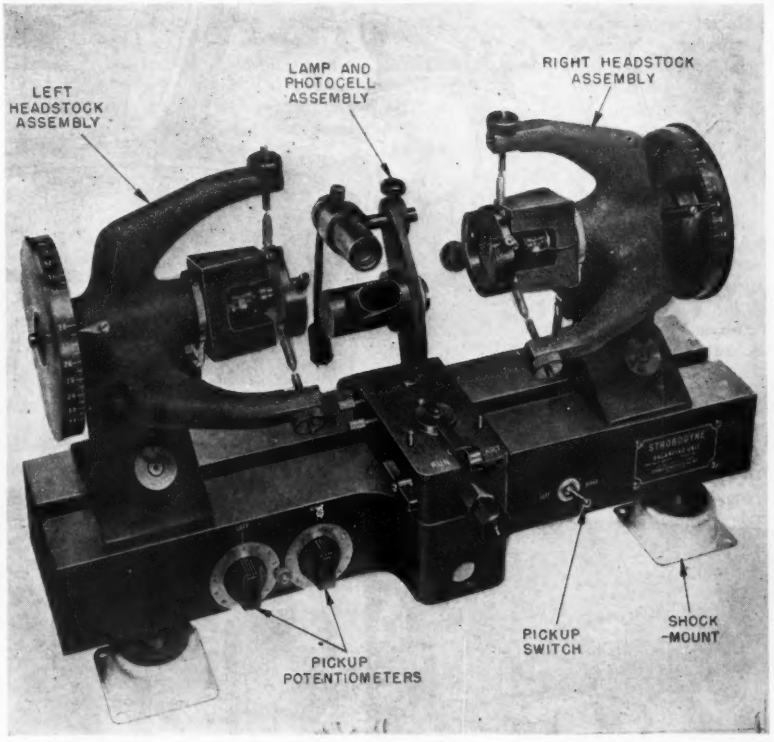
Magnetic Inspection of Welds. Gilbert C. Close. How magnetic inspection methods provided the solution to the problem of inspecting thousands of welds in steel airframe assemblies is briefly described. The writer then explains certain principles of magnetic inspection and describes how they may be utilized to detect defects in ordinary fusion welds in all ferrous materials. The information was assembled in one of the large aircraft plants but has general application to the fusion welding of magnetic materials. *Steel Processing*, February, 1946, pages 122–125, 6 illus.

Instrument Flying

Airspeed and Imagination. Wolfgang Langewiesche. A comprehensive interpretation of the functions and operation of the air-speed indicator. The writer advances the theory that, properly understood, this instrument allows the pilot's imagination to "see" the airplane's behavior in the up-and-down sense while flying "blind." *Air Facts*, March, 1946, pages 63–78, 13 illus.

Instruments

Design of Supersensitive Balancing Equipment. Karl F. Frank. Difficulties encountered in the precision balancing of small high-speed rotors by hand are set forth, and the problems involved in microbalancing are enumerated. How equipment was developed to meet microbalancing requirements is included. It is stated that design considerations were the choice of vibration pickup, rotor suspension, a system of indicating unbalance position, filtering the vibration signal, means for driving the motor, and unbalance-removal equipment that would not require any computation on the part of the operator. The construction of the equipment designed to meet supersensitive balancing requirements is described in detail. Principles of operation are explained. *Machine Design*, February, 1946, pages 109–114, 180, 182, 7 illus.



Photograph Courtesy Sperry Gyroscope Company, Inc.

Balancing unit on which electrical impulses for determining magnitude and position of unbalancing are generated. At the *left* are air-driven gyro rotors and, *right*, electric gyro rotors mounted in balancing cradles.

Aircraft Instrument Service and Sales. Henry N. Droge. Explaining why the aircraft-instrument manufacturer must select service representatives who are not only qualified repair men but who also have adequate testing equipment, the Service Manager of Kollsman Instrument Division of Square D Company describes a test panel that can be rented, thus eliminating the initial large investment formerly required for instrument-testing equipment. The panel contains devices for testing all types of pressure-operated instruments and tachometers. It is expected to be rentable at a fee between $35 and $45 a month. Composition of the panel is detailed, and the advantages it offers to operators are noted. In addition, the writer offers some advice about the stocking, display, and selling of aircraft instruments and spare parts. *Airports*, February, 1946, pages 23, 24, 2 illus.

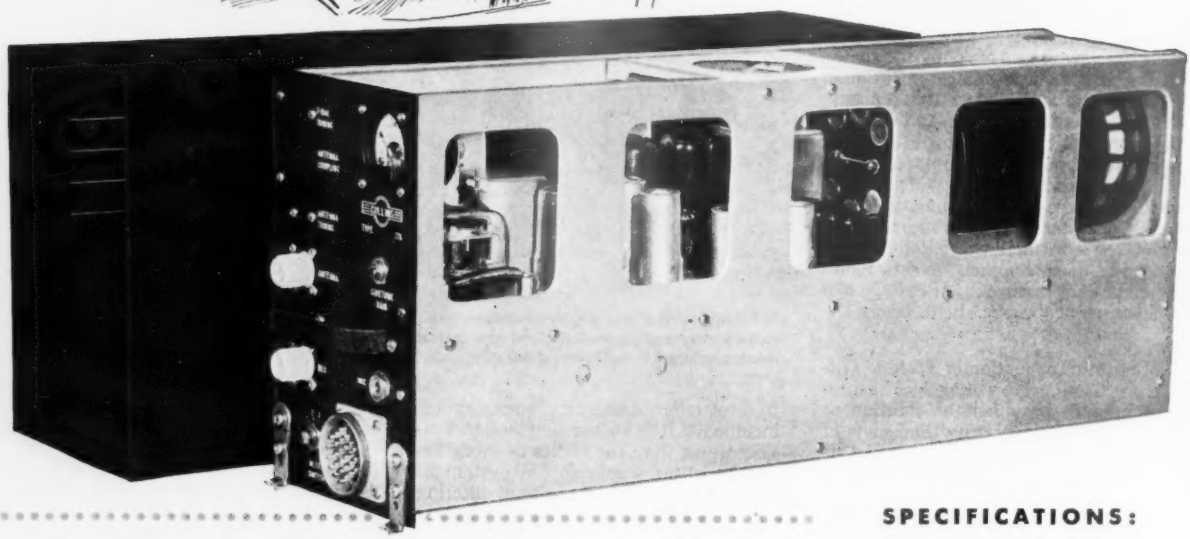
Maintenance

Dock for DC-4's and DC-6's. M. B. Crawford. How United Air Lines designed and built an overhaul dock for maintenance work on its DC-4 and DC-6 transport aircraft is described. Illustrations show the construction of this maintenance unit, which consists of six major sections: the nose dock and access stairways at the front of the airplane; the engine docks, which are made at two different heights for access to the engines; the wing ramp, which extends from the inboard nacelle beyond the wing tip; the door access ladders; the side scaffolding or catwalk; and the tail stands. *Air Transport*, February, 1946, pages 35–41, 20 illus.

Aircraft Sheet Metal Layout and Forming. Louie Boer. Pointers on sheet-metal forming as applied to the repair of aircraft are supplied. Methods of laying out work where several bends are involved are described. Charts show bend allowances for nonferrous metals. *Aviation Service Magazine*, February, 1946, pages 20–24, 8 illus.

Wartime Repair of Bombers. C. Baker. A retrospective survey of the work entailed and the procedure adopted for the maintenance and repair of war-damaged British bombers. As a prelude to the discussion, the writer outlines routine maintenance methods. He then describes methods of classifying damage, typical repair instructions, the

The Collins 17K-1 Transmitter



Lightweight VHF for Aircraft

The 17K-1 is a five frequency, crystal controlled radio transmitter for commercial and itinerant aircraft use in the 122-132 mc band. The complete transmitter, including a dynamotor power supply, is housed in a single ½ ATR unit cabinet. Transmitter, control box, and interconnecting cable weigh less than 20 pounds.

Remote control facilities allow complete freedom in locating the 17K-1 in the plane. An antenna transfer relay is available, if desired, in order to operate a receiver from the transmitting antenna.

The power output, adequate for the VHF range, is conservatively rated at 5 watts. Total power drain is held to a minimum during both stand-by and operation.

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The 17K-1, thoroughly engineered and flight tested, enables its owners to obtain maximum benefit from the new VHF aircraft frequencies. Write today for early delivery. The Collins Radio Company, Cedar Rapids, Iowa; 11 West 42nd Street, New York 18, N. Y.

SPECIFICATIONS:

Frequency range: 122-132 mc.

Size: ½ ATR unit.

Total weight: less than 20 pounds.

Number of frequencies: five.

Frequency control: quartz crystals.

Power output: 5 watts minimum.

Type of emission: voice modulation.

Output impedance: 50 ohm concentric line.

Power source: 12 volts d-c or 26.5 volts d-c.

IN RADIO COMMUNICATIONS, IT'S . . .

COLLINS

inspection of damage, and some typical and special repairs. *Aircraft Engineering*, January, 1946, pages 29–31, 7 illus.

Marketing

The Aviation Export Battle. Fred Hamlin. Some of the factors that affect foreign marketing of United States aircraft are studied. First, it is shown that Great Britain has started on an export program that will require some vigorous sales planning to excel. Efforts of both the British Government and the Society of British Aircraft Constructors to promote the British campaign are noted, while a comparison is made between the functions of the Aviation Industries Association in the United States and those of S.B.A.C. in Britain. Secondly, the question of the condition in which surplus American aircraft are sold overseas is examined. The third consideration covers monetary advantages and disadvantages, such as financing, trade balances, foreign exchange, and international loans. *Flying*, March, 1946, pages 26, 27, 78, 80, 3 illus.

Materials

Forming Laminated Sheet. Materials and methods developed by Bakelite, Ltd. for the forming of laminated plastic sheets are examined. Following a discussion of the qualities and characteristics of the Bakelite laminated sheets—measuring up to 8 ft. by 4 ft. and varying from $^1/_{64}$ in. to $^1/_4$ in. in thickness—which are now available and of the general differences of laminated materials from metals, forming procedures and the tools used for them are considered. One method of forming which is detailed is the Guerin (rubber press) process employed for metal forming. Other procedures described are the bending of radii in forming angles, methods of closing the molds, the handling of the materials when inserting them into the molds, and the application of correct pressures. Principal properties of Bakelite forming material are tabulated. *Aircraft Production*, February, 1946, pages 55–57, 6 illus.

Synthetics Hold Aromatic Fuels. W. A. Parrish. An account of how aircraft fuel-system parts were compounded from synthetic rubber to resist the conditions imposed by aromatic fuels. In addition to explaining the problems caused by the use of aromatic fuels which necessitated the development of a special-purpose butadiene-acrylonitrile copolymer, the writer describes the qualities of this synthetic material and its superiorities over natural rubber for the particular applications. He also lists other aircraft applications that have been found for the Hycar Chemical Company product. A brief description of a fuel-selector valve aids in understanding the reasons for the requirements of the synthetic rubber in the manufacture of aircraft parts used in conjunction with rubber-dissolving fuels containing aromatic hydrocarbons. *Aero Digest*, February, 1946, pages 62, 155, 4 illus.

Magnesium-Cerium Alloy Castings for High Temperature Use. R. F. Marande. The major portion of the article is devoted to a detailed discussion of melting and casting methods that have been found necessary in handling the magnesium-cerium alloys in the foundry. Some of their properties and uses are mentioned to illustrate the successful employment of these alloys in high-temperature applications. The use of magnesium-cerium alloys for pistons is considered. Illustrations show a forged supercharger impeller and a rear cam follower guide made from magnesium-cerium alloys that were found on a German aircraft and a motorcycle piston made from this alloy which has been operated at 4,500 r.p.m. with complete success. *Materials & Methods*, February, 1946, pages 418–424, 4 illus.

Magnesium Die Castings. Part I. Ralph M. Heintz. Part I of a serial article by the Vice-President and Secretary of Jack & Heintz, Inc., on the die casting of magnesium, deals with general die-casting design, including aeronautical applications. The characteristics of the sand-casting and die-casting processes are listed and compared. It is explained that, ordinarily, a die-cast magnesium machine part falls into one of four classes—decorative, functional, structural, and stressed. Each of these design factors is discussed. Specifications and properties of magnesium die-casting alloys called for by various agencies and an appraisal of die-cast magnesium as a structural material are included, as well as other specific data about magnesium. The comparative weights and costs of a typical magnesium part as made by sand casting and by die casting are also listed. Certain phases of design are detailed. *Machine Design*, February, 1946, 101–104, 180, 5 illus.

Medicine

Aero Medical Aspects of Cabin Pressurization for Military and Commercial Aircraft. W. R. Lovelace, II, and A. P. Gagge. Whenever aircraft fly at high altitudes for long periods of time and over long distances, the foremost design requirement for aircrew efficiency and passenger comfort is cabin pressurization. In military aircraft, cabin pressurization is used to eliminate completely the need for continuous use of oxygen, to prevent aeroembolism only, or simply to reduce the cabin to a level where use of pressure breathing is not required. In commercial aircraft, the health, comfort, and safety of the passengers are of prime consideration. In military aircraft, a significant hazard introduced by cabin pressurization is explosive decompression caused by structural failure of the cabin when under enemy gunfire. Criteria are presented by which safe operating differentials may be chosen to minimize this hazard. The advantages of isobaric cabin altitudes below the now conventional 8,000-ft. level for military aircraft are reviewed as they apply to passengers of commercial aircraft. Finally, emergency procedures necessary for crew and passenger safety in case of failure of the cabin-pressurization system are discussed. *Journal of the Aeronautical Sciences*, March, 1946, pages 143–150, 5 illus.

The Eye-Test Fallacy. Leon J. Alger. The writer claims that present depth-perception tests do not actually measure vision and that, unless better testing means are devised than are currently in use, no depth-perception test whatever should be required in pilot physical examinations. He defines nine different sensations that give the human eye a sense of depth or distance: (1) distance as interpreted from size; (2) intervening objects; (3) a real perspective; (4) geometric perspective; (5) distribution of light and shade; (6) motion; (7) accommodation; (8) stereoscopic influence of dissimilar images; (9) muscle sensation of position of the two eyes. It is then pointed out that, although sensations 8 and 9 are of no value for objects over 15 ft. away, the pilot who is dealing with objects at a minimum of 15 ft. is tested only for those two sensations which are of no importance to his flying technique. A further contention in support of objections to present depth-perception tests is that estimation of distances of more than 15 to 20 ft. depends upon an intelligent interpretation of phenomena which all eyes have the power to behold. *Flying*, March, 1946, pages 33, 34, 116, 118, 3 illus.

Diseases and Defects in Aircrew Trainees. Part III. Major Oscar M. Marchman, Jr. In the third of a series of surveys of diseases and defects observed in 344,134 men examined for aircrew training at Army Air Forces Classification Centers and Army Air Forces Basic Training Centers, diseases and defects of the visual system are analyzed. The examining system and equipment are described. A comparison is made of the various types of ocular defects and diseases found per thousand examinees, and the results of the survey are summarized. *War Medicine*, November-December, 1945, pages 371–375, 1 illus.

Model Airplanes

Italian Diesel Engine. Jim Watson. Progress in the development of model engines of the compression-ignition type is reviewed with particular reference to engines built in Italy. It is observed that the usual electric-ignition engine for model airplanes has several disadvantages, one of which is the dead weight of the electrical equipment. There has also been a shortage of such equipment as batteries and coils in Italy, which has resulted in more attention being given to the compression-ignition type of engine. Problems involved in the development of compression ignition engines are outlined. Italian compression-ignition types described include the Antares, 0.24-cu.in. displacement; Giglio, 0.12-cu.in. displacement; Movo, 0.12-cu.in. displace-

ment; and Mancini Alfa, 1.08-cu.in. displacement. *Model Airplane News*, March, 1946, pages 16, 46, 47, 3 illus.

Personalities

Langley Goes Down to the River. John Hettich. The second sketch and the third article in a series reviewing the careers of the pioneers of aviation and their exploits. The current article outlines the aerodynamic experiments made by Samuel Pierpont Langley during the years 1886–1896. Successive airplane models developed by Langley are described, including the one that achieved sustained flight for $1^1/_2$ minutes and a distance of 3,000 ft. *Aero Digest*, February, 1946, pages 38, 160, 161, 1 illus.

Photography

Site Selection by Air Photography. Jack Hamilton. Indicating the advantages of such a method, the writer recommends the selection of airport sites by means of aerial photography. Through aerial photographs and maps made from them, it is reasoned, airport planners can note all property involved and all obstructions to be razed, analyze tax maps in conjunction with the project, and consider all pertinent factors. Such surveys can be made without giving property owners advance knowledge of the plan, thereby avoiding an unreasonable rise in the price of the desired realty. Two possible methods of selecting sites through aerial photography are explained: one based on a series of oblique views; the other, mapping by means of vertical photographs. *Airports*, February, 1946, pages 50, 51, 4 illus.

The Beginnings of Photographic Reconnaissance. H. Hemming. The prewar development of aerial photography and survey work in Britain is outlined briefly. The history deals mainly with the operations of private enterprises leading up to formation of the (British) Central Interpretation Unit. The evolution is traced through its successive changes into the Photographic Development Unit, the Photographic Development Interpretation Unit, the Photographic Reconnaissance Unit, and the Photographic Interpretation Unit. *The Aeroplane*, January 11, 1946, pages 53–55, 5 illus.

The Williamson Aerial Camera. A. James Payne. A brief description of the Williamson O.S.C. Mk. 1 photogrammetric air camera is supplemented by a series of general notes about the development of aerial photography equipment. Among other things, these notes refer to the international history of the air-camera industry during the decade preceding World War II, comparative characteristics of British equipment and that manufactured by the Germans and Americans, and the different requirements for photo-reconnaissance and air-survey work. *Commercial Aviation*, January, 1946, pages 25, 26, 4 illus.

Plastics and Plywood

Structural-Type Paper-Base Laminates: Their Properties and Characteristics. Charles F. Marschner. The first part of a serial study of the group of plastic laminates having paper and paper-like fillers and thermosetting resin binders. The study is based on work performed by the Forest Products Laboratory and several private organizations. General conclusions are offered about the mechanical and physical properties of structural-type laminates. The writer reports the results of tests and experiments under various methods of manufacture, showing how improved characteristics have been obtained. Tables of data and stress-strain curves for Papreg at normal temperatures are included. *Pacific Plastics*, February, 1946, pages 34–36, 47, 4 illus.

Private Flying

New Planes for Personal Flying. Developments that will make private flying cheaper and easier are described. It is stated that two major developments in personal flying of importance to both the beginner and experienced pilot are the appearance of "spinproof" and "spin-resistant" airplanes and the fact that large aircraft companies with military experience are beginning to break down the high costs of personal flying. Aircraft that illustrate these developments are listed, and figures on the cost of flying are supplied. A "shopper's guide" gives the important specifications of 1946 airplanes. *Fortune*, February, 1946, pages 124–129, 154, 156, 158, 10 illus.

Canada's Flying Clubs. James Montagnes. Plans for the continuation of Canada's flying clubs are outlined. Beginning with a brief account of the activities of these clubs before the war and of their contribution to the war, the article goes on to reveal what their program is for the future, how they expect to finance their projects, what equipment and facilities they will use, what their dues will be, what insurance will be carried and required, etc. The organizational setup of the association is described. *Flying*, March, 1946, pages 44, 45, 106, 107, 2 illus.

Production

Forging with Closed Dies in Hydraulic Presses. C. W. Hinman. The use of closed dies in hydraulic presses for forging operations is investigated. It is observed that this process has gained favor in industry. The difference between the design of forged dies for hydraulic processes and those used in drop hammers is explained. Advantages of hydraulic press forging are outlined and aluminum aircraft parts made by the process are illustrated. *Machinery*, February, 1946, pages 176–178, 7 illus.

Fabricating Aluminum Into Difficult Shapes. It is observed that close cooperation during recent years between the producers of aluminum-alloy sheet, the pressed-metal industry, and manufacturers of presses greatly expanded the use of stamped aluminum parts for radio and radar equipment, airplane engines and other parts of airplanes, bombs, and other items of war material. Some examples of deep-drawn aluminum parts that were difficult to shape are given. How the manufacture of aircraft-engine cylinder heads on mechanical presses facilitated production operations is described. *Modern Metals*, February, 1946, pages 27, 29, 3 illus.

Light Plant Production Line. V. C. Baltz. The mechanized conveyer system by which Aeronca Aircraft Corporation assembles planes is depicted by a series of 10 photographs showing the progressive routine. Descriptive details about the conveyer, together with a list of the advantages the system affords, supplement the pictures. *Airports*, February, 1946, pages 30, 31, 10 illus.

Rapid Grinding of Milling Cutters for Continuous Production. The article describes a method by which the teeth of milling cutters can be rapidly ground. The method was developed at the plant of the Bell Aircraft Company and is stated to have proved to be efficient and workable. The procedure involves a separate grinding body with multiple blade-receiving slots and a fixture for holding and for spinning the grinding body. In operation, the blades are rough- and finish-ground, the ends being ground cylindrical. Shapes and contours, when required, are controlled by a templet attached to the fixture and operating against a nib fastened to the table of the grinding machine. *Machinery*, February, 1946, page 179.

Machining of Aluminium and Its Alloys. The article deals with the influence of tool form, cutting speed, depth of cut, and allied factors on the surface finish, output capacity, and tool life when turning aluminum and aluminum-base materials. It is based on articles by E. von Burg that appeared in *Schweizer Archiv*, October, 1944, and *Technische Rundschau*, 1945, Nos. 48, and 49. *Light Metals*, February, 1946, pages 94–104, 26 illus.

Aluminum Alloys Foundries Equipped for Large Scale Production. Joseph Geschelin. The application of quantity-production methods and new techniques for the manufacture of aluminum-alloy castings is described. The article has reference to operations at the Walton and St. Aubin plants of the Aluminum Alloys Corporation, Detroit. The Walton plant was converted into a modern sand-casting foundry during the war, and the new St. Aubin

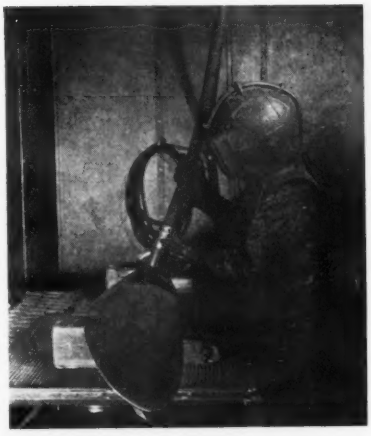
plant was built expressly for the production of aircraft parts, such as blower housings, cylinder heads, crankcases, oil pans, etc., by sand-cast and permanent-mold methods. Foundry operations at both plants are described and illustrated. *Automotive and Aviation Industries*, February 1, 1946, pages 28–32, 11 illus.

Cam Grinding on a Cylindrical Grinder. Frank Zagar. A grinding operation on an aircraft part which required a departure from conventional methods is described. The problem was that of grinding the cam surfaces on a coupling device on a bomber. The specifications called for a definite radius to be blended perfectly with the two flats on the sides. An oscillating spindle was developed which permitted the flat and the radius to be ground at the same time. *Machinery*, February, 1946, pages 180, 181, 3 illus.

Steel Spar Casting. The design of the steel casting for the rear spar frame of the Hawker Tempest fuselage is reviewed, and Hadfields Ltd. methods of manufacturing it are detailed. Following an account of the design modifications that were necessary for the use of the casting in place of the assembly of steel tubes and forgings originally intended for the rear spar frame, the processes of manufacture are traced through the fabrication of the cores and molds, making and pouring the steel, preliminary inspection and heat-treatment, rough machining and inspection, heat-treatment and mechanical testing, and proof loading. The reduction of wastage to a minimum is noted. Numerous drawings, photographs, and tables supplement the details reported. *Aircraft Production*, February, 1946, pages 85–94, 28 illus.

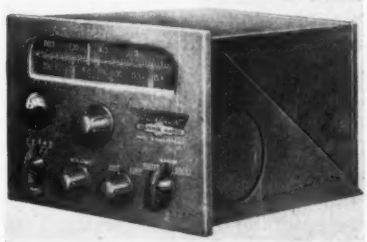
Latest Developments in Honing Techniques. L. S. Martz and D. T. Peden. Advances in honing techniques are discussed, with particular reference to the forming, sizing, and finishing of cylinder bores. Emphasis is placed on the importance of controlled reproducibility in cylinder-bore wall quality. Aeronautical engineering practice in that sort of work is reviewed. *Steel Processing*, February, 1946, pages 98–103, 13 illus.

High Velocity Band Sawing. H. J. Chamberland. How the aircraft industry received particular benefit through the introduction of the high-velocity band-sawing technique is explained. The various types of machines now available with speeds ranging from 50 to 15,000 ft. per min. are outlined, with details concerning the other characteristics of such machines and the blades used with them. Particular advantages of the special blades now available are compared with the use of standard band blades. It is stated that when working with wood and plastics the high-velocity band-sawing technique has practically replaced the conventional procedure. A detailed description is given of the methods of band sawing as applied to these materials. Saw-control factors and sawing rates for materials used in aircraft production are tabulated. *Automotive and Aviation Industries*, February 1, 1946, pages 18–21, 58, 60, 4 illus.



A worker at the Experimental Department of Hamilton Standard Propellers Division, United Aircraft Corporation, experimentally shot-blasting a propeller blade. The rubber apron, heavy work clothes, and a diver's-type helmet are required to protect the worker from the pellets that are expelled from the hose under pressures up to 85 lbs.

Infra-Red Drying. As adopted by British firms for the drying of paint finishes on aircraft components, three General Electric and two Metropolitan Vickers infra-red drying plants are described. The first General Electric system is one installed by Folland Aircraft, Ltd. for treatment of wing leading-edge subassemblies and complete wings of the Seafire; the second is one used by Rubery Owen, Ltd. for baking paint on aircraft steel jettison-tanks; the third is an installation carried out for British Overseas Airways Corporation Ltd. for the purpose of baking paint on radial-engine components during overhaul and repair. The two Metropolitan-Vickers plants referred to are installations at Gloster Aircraft Ltd.—one used for Meteor monocoque fuselage and nose sections; the other, for Meteor wings. *Aircraft Production*, February, 1946, pages 76–78, 6 illus.



The Radio Division of the Bendix Aviation Corporation has announced its first two-way communications unit for personal airplanes. The five-channel very-high-frequency transmitter is combined with a range and broadcast receiver. The equipment, known as the PATR-10 Flightphone, weighs only 7 lbs., including a built-in power supply, shockmounts, and range filter. The entire unit fits in a 5- by 7- by 7-in. space in the instrument panel.

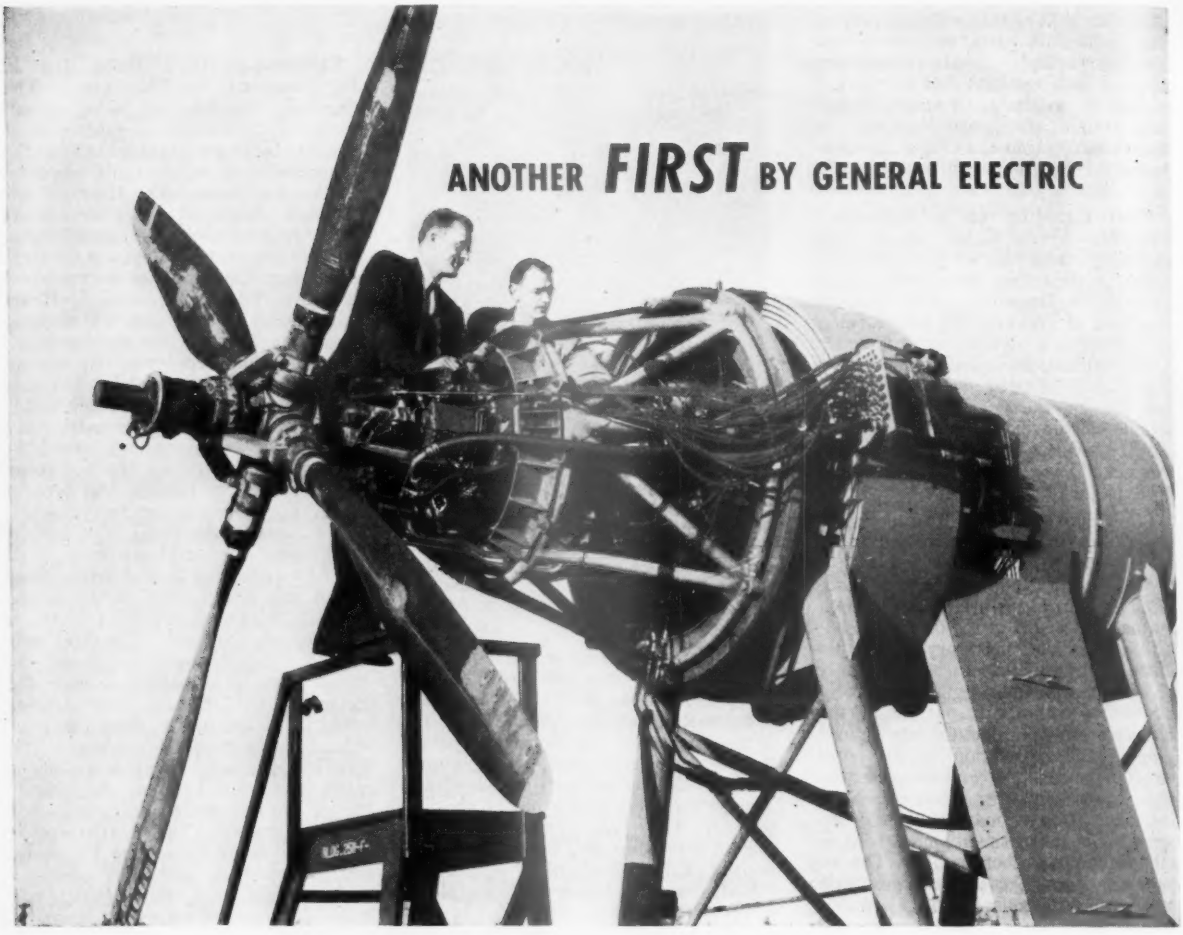
Radio

To Pulse or Not to Pulse, That Is the Question! By "Navigus." The operating principles of radar instruments are explained in nontechnical language and are compared with the principles upon which radio signaling devices are based. The theoretic advantages attributed to radar are its ability to cut through local interference, immunity from errors caused by local reflections, and economy as measured by the portion of the radio spectrum that a series of radar sets will require. In showing how some of the shortcomings of the radar pulse system can be overcome, such as the inability to measure extremely small distances, the writer reviews the four types of radar commonly used for navigation. Each of these types is described, the first being designated as the fundamental type in which a ground transmitter and receiver measure the distance of an aircraft from the ground instrument. The second type is that in which the transmitter and receiver are carried in the aircraft, this being called the air-borne radar search principle. The third type of radar navigational equipment resulted from the attempt to increase the range, so that signals from airfields could be picked up by aircraft at considerable distances by means of "responder" beacons. That development made it possible to guide the aircraft "home" to its airfield and measure the distance exactly. The fourth type is known as radar hyperbolic fixing, by which a complete system of air-traffic control is laid down, similar to that of a railroad. The comparison of radar and radio methods is summarized by the statement that radar will be preferred for all branches of air navigation except for the measurement of small distances such as may be required for "blind" landings, for which radio equipment has superior advantages. *The Aeroplane*, January 18, 1946, pages 74–76, 8 illus.

Two-Way Radio. Joe James. Users of two-way aircraft radios are advised on the proper language to use in contacting the control tower operator. The suggestions cover the obtaining of radio checks, communication while cruising, and approach procedure. *Southern Flight*, February, 1946, pages 32, 33.

Where's Radar? Robert B. Sibley. The C.A.A. is criticized for what is termed a policy of furthering its own instrument-landing glide-path equipment and neglecting the promotion of radar as an aid to air navigation. Evidence is offered to show that Ground Controlled Approach (radar) is both practical and inexpensive for civil aviation, while the C.A.A. equipment is costly as to both initial expense and maintenance. *Yankee Pilot*, February, 1946, pages 14, 15, 20, 2 illus.

Radar Measures the Airlanes. Details of the functions, construction, operation, and applications of the Airborne Distance Indicator are supplemented by an account of the develop-



Push and Pull Engine

PRECISION PRODUCTS
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This new engine represents another departure from convention—it's a G-E aircraft gas turbine designed for propeller drive. Engineers have long known that such engines should be most effective on long-range, high-speed ships, and early last summer one was installed in an experimental Army plane. Tests to date indicate that the enormous power developed by this type of engine will mean the opening of a new era in aircraft design and faster world travel.

Called the TG-100, this engine utilizes most of its power to drive the propeller —the rapidly spinning turbine driving through specially designed reduction gears. Additional thrust is obtained by jet propulsion from exhaust gases. Airmen will like the TG-100—its light weight, simplicity, virtually no vibration, continuous high power, and fuel economy on long-range, high-speed ships. Here, G-E engineers have combined the best features of each type of propulsion —cancelling out the limitations of each to obtain an engine of superior design and power. General Electric is continuing research in this field, and our engineers will be glad to answer your questions about this and any other equipment we have developed for the Aviation Industry. *Apparatus Dept., General Electric Company, Schenectady 5, New York.*

GENERAL ELECTRIC

674-51C-8872

ment of this radar instrument by Canadian experimentalists, a description of an adaptation that has been made by the Radio Branch of the Canadian National Research Council, and an outline of the program by which the Research Council expects to continue its commercial radar developments in the future. Designed to give the pilot a continuous record of his distance from one or more ground beacons set at intervals of 100 miles along the route, the indicator is described as a compact air-borne radar set which, in the form of an indicating needle creeping around a dial, gives the pilot knowledge of his position within 1 mile at all times. Essentially, it consists of a transmitter that sends out a continuous series of pulses on a frequency of 202 megacycles. The pulses flow out from the antenna and are picked up by a receiver in the ground beacon which "triggers off" the powerful ground transmitter so that strong pulses are sent back on a frequency of 222 megacycles. Each reflected pulse is then picked up by a second component of the air-borne equipment, the receiver; while a third and complicated component times the round trip, takes into account the speed at which the pulses travel, and calculates the total distance traveled. This figure, divided by two, is then transmitted by a flexible cable to the meter on the pilot's instrument panel. *Canadian Aviation*, February, 1946, pages 26, 27, 56, 2 illus.

Reaction Propulsion

Some Elementary Details of Ramming Intake and Propulsive Jets for Airplanes. Sanford A. Moss and W. R. Foote. The operation of any usual airplane requires that an appreciable quantity of air be taken on board the plane from the atmosphere and that this air later be discharged. The air may be used for combustion in the engine, for cooling of the engine or other parts, for a propulsive jet, or for some other purpose. Frequently, the intake of air is by means of a suitably located ram whose diffuser increases the static pressure of the air in a supercharger or engine inlet or provides pressure to force air through a cooling duct. At discharge, air or exhaust gases may be directed rearwardly and so exert a propelling force on the airplane. The limit of this is an airplane driven by propulsive jets rather than by a propeller.

The intake of air exerts a retarding force on the airplane, a theoretical value of which may be found by the application of Newton's laws of motion. A theoretic value of the propelling force of a jet may be found in a similar fashion. These forces exist whenever air is taken on board the plane and air or exhaust gases are discharged from it, regardless of the use on the airplane. It is the purpose of this article to give theoretic values of the forces, powers, and energies for these cases and to discuss them briefly for an airplane flying at constant altitude without acceleration.

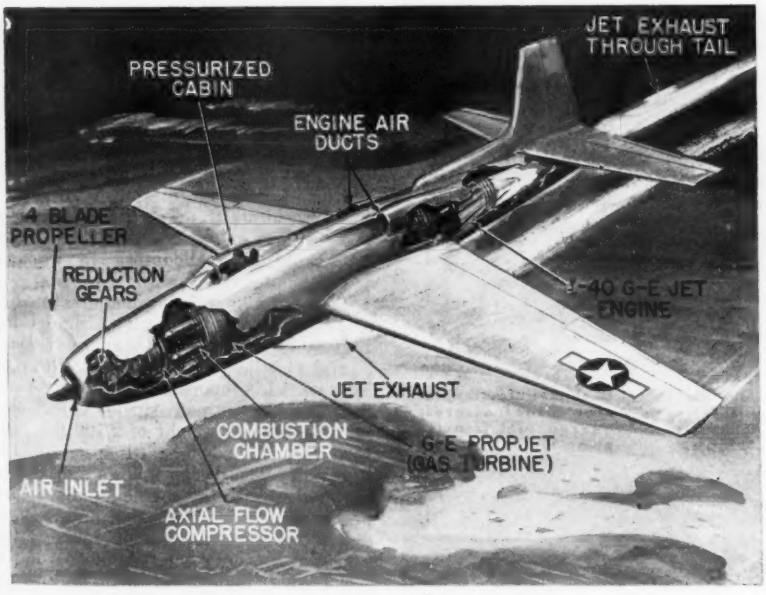
The writers explain the operation of a ramming intake, the calculation of the pressure rise that can be produced, the retarding effects, and the nature and extent of the forces that prevail at the discharge. Expressions are derived for the net propulsive energy, the kinetic energy loss, and the net potential energy added to the gases. It remains to find the best value of the airplane speed, for which mathematical calculations are worked out. An appendix contains an explanation of, and formulas for, computing the pressure on the walls of a vessel which provide the jet momentum forces. A major use of those equations is in the measurement of nozzle velocity by weighing nozzle reaction. The general purpose of the appendix is to show the parts played by the fluid pressures on the walls of the vessel. *Journal of the Aeronautical Sciences*, March, 1946, pages 111–117, 2 illus.

A Liquid Propellant Rocket Motor. Lovell Lawrence, Jr. The writer discusses the type of rocket engine that consists basically of an injector, the counterpart of the reciprocating engine's carburetor, a combustion chamber, a nozzle, and a cooling jacket. Sections are given to a study of combustion factors, propulsive action; propellant consumption; thermal, propulsive, and overall efficiency; and the use of the liquid-propellant rocket for assisting take-offs of heavily loaded aircraft. *Journal of the American Rocket Society*, December, 1945, pages 8–10, 3 illus.

The Jet-Engine Fuel System. The construction and operation of the fuel system developed by the firm of Joseph Lucas, Ltd., for Rolls-Royce jet engines are detailed. The components of the system are listed as a variable-stroke pump with a built-in maximum-speed governor and an automatic pressure-relief mechanism; barometric control unit; throttle valve; a unit embodying accumulator, trip valve, and high-pressure cock; fuel manifold; and the burners. Each component is described, and its functions are traced by following the flow of the fuel from the pump to the burners. How the various parts are assembled and adjusted and what work they perform are explained with the aid of "cutaway" drawings and diagrams of the connections. *Flight*, January 10, 1946, pages 41–44, 9 illus.

Nozzles. William D. Monroe. The controversy over the possibility of nozzle-less jet engines is held to be of only academic value, since there are no true nozzle-less jet devices for supplying power at the present time. The so-called nozzle-less devices are stated to be units that combine the combustion chamber and the nozzle. Jet devices are considered in the light of an exact definition of nozzles and their functions. The operating principles of various types of jet engine are reviewed. Among the conclusions reached are the following: Combustion chambers properly designed to burn the fuel mixture almost entirely in the engine will take over, at least partially, the function of the nozzle. Energies should be directed toward (a) designing units combining both combustion chambers and nozzles and (b) seeking new shorter nozzles or a practical way to shorten the present ones without sacrificing efficiency. *Journal of the American Rocket Society*, December, 1945, pages 12–14.

V-2—And Beyond. Part I. Willy Ley. The first of two articles on rocket development by the Germans describes the research and experimental work carried on at the rocket institute at Peenemunde. The organization of the institute is outlined and the steps by which German preoccupation with liquid-fuel rockets progressed are reviewed in sequence. Comprehensive



Consolidated Vultee Aircraft Corporation's XP-81 fighter. As shown in the above illustration the propeller is driven by a gas-turbine engine, and a jet engine is installed in the rear section of the fuselage.

descriptions of the rocket projectiles developed by the Germans follow, beginning with the A-1, completed in 1933, through the A-2, A-3 (first project of the Peenemunde institute), and A-4 (or V-2). The account of the development, design, construction, features, and applications of the A-4 is particularly detailed. *Air Trails*, March, 1946, pages 26–28, 109–114, 6 illus.

An Introduction to Jet Propulsion. G. Edward Pendray. A paper presented at the Rocket Dinner of the American Society of Mechanical Engineers, November 26, 1945, explains the fundamental principles of jet propulsion. Five types of reaction engines are described and illustrated. The efficiency of jet-propulsion engines is examined. A schematic design of a proposed sounding rocket intended for vertical flight, carrying instruments, is also included. *Journal of the American Rocket Society*, December, 1945, pages 15–20, 4 illus.

Small Motor Fuel Injection. David Elliott. The results of the writer's investigation of sprayer devices for a simple intermittent jet engine are reported. In the type of nozzle found to be most practical, two extremely fine streams of liquid are shot directly at each other, so that when the streams meet they break into a finely divided mist. Descriptions of the engine and fuel sprayer are given. *Journal of the American Rocket Society*, December, 1945, pages 11, 25, 1 illus.

Reconversion of Equipment

Modification of the UC-78. William L. Blythe. With some of the more important procedures outlined, the 32 steps in the "deluxe" modification work offered by Southern Airways for the conversion of the UC-78 to the civil T-50 are listed. While it is reported that this "deluxe" modification requires 30 days for completion, another type of modification service for the UC-78, requiring only 2 weeks, is also noted. The number of man-hours consumed in each of the stages of the more thorough modification is included in the tabulation. In addition, the article gives general information about the cost of purchasing the UC-78 five-place Cessna planes from the Army and the work that is needed to qualify them for civilian use. *Aero Digest*, February, 1946, pages 78, 79, 2 illus.

Research

Aeronautical Research in Canada. With emphasis on the research activities carried on there, facilities of the Aerodynamic Building of the Canadian National Research Council are surveyed. Some of the aerodynamics problems that have been solved in the wind tunnels in the building are described, and a partial list of the products that have been tested there is included. *Canadian Aviation*, February, 1946, pages 28, 29, 80, 82, 8 illus.

Rotating Wing Aircraft

Helicopters . . . for Forest Fire Control. David P. Godwin. The employment of helicopters in forest-fire control and other forest activities is reviewed. It is stated that, because the helicopter can land and take off in restricted areas, it could be used to deliver men and supplies in innumerable spots throughout forest areas. The writer mentions some preliminary activities directed toward, and investigation of, possible forest uses of rotary-wing aircraft. *American Helicopter*, February, 1946, pages 21, 22, 32, 3 illus.

Building Helicopters in Canada. Brief notes describe the S.G. Mark VI helicopter, now being manufactured in Montreal for the Intercity Airlines Company. Based on a design by Sznycer and Gottlieb, of New York, the S.G. Mark VI is reported to be a three-place helicopter with a single four-bladed rotor, a gross weight of 2,100 lbs., and an anticipated forward speed of 120 m.p.h. The design follows automotive practice, with the engine mounted horizontally behind the cabin and a spiral beveled-gear transmission relaying the power to the rotor. A model of the helicopter is depicted in three different views. *Canadian Aviation*, February, 1946, page 54, 3 illus.

Rotary Wing Icing. B. P. Mazonson. An account of icing tests on

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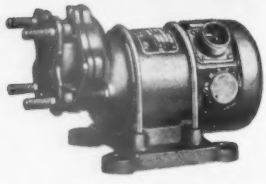

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rotary-wing airfoils which were conducted by the Propeller Laboratory and Helicopter Test Branch of the Air Technical Service Command. The primary aim of the tests, which were carried out on Whiteface Mountain, Lake Placid, was to determine what ice build-up would occur, if any, on the main rotor blades. Measures were taken to prevent the helicopter from leaving the ground or rotating because of torque reaction. Three typical tests are described and the results are summarized. It was found that in rotary-wing aircraft ice reduces both lift and thrust and can cause the blades to fold up completely. *American Helicopter*, February, 1946, pages 10–12, 28, 4 illus.

It Shouldn't Happen to an Airfoil. William B. Stout. Engineering limitations of the helicopter are analyzed. Among the deficiencies with which the helicopter is charged are those caused by dual-rotor problems and the counter-torque propeller, the requirement of a great amount of power in proportion to the pay load, and the fact that one side of the rotor normally lifts four times what the other does. It is the writer's opinion that, if the utility of the helicopter is to be extended, aircraft engineers must develop a new set of assumptions for its design. He outlines a few of his own ideas, one of which involves the use of two single-blade rotors with counterweights. *Southern Flight*, February, 1946, pages 34–36, 1 illus.

Helicopter Reaction Propeller Drives. Cedric Giles. Possible applications of reaction-propeller drives to rotary-wing aircraft are considered. The principal advantages credited to the use of jet propulsion for actuating free-turning rotors mounted on stationary shafts of rotary-wing aircraft are listed. Some of the problems to be overcome are also mentioned. Various jet designs are described and sketched. *Journal of the American Rocket Society*, December, 1945, pages 2–6, 18 illus.

Practicability of Design. Sergei Sikorsky. Design factors that must be considered in the development of efficient commercial helicopters are discussed, and the importance of designing for low operating costs is stressed. It is stated that the present need for operating the engine at practically full throttle at all times is the cause of excessive gasoline consumption and strain on the power plant. Other factors that result in high maintenance cost include the complicated and delicate transmission system and rotor blades that are expensive and interchangeable only in sets because they are hand-built. The use of a single blade with a counterbalance is suggested. Consideration is given to future changes in instruments and flight controls. It is concluded that the complexity of the helicopter at present curtails its market and that quantity production will be a prerequisite to any drastic drop in the cost of the helicopter. *American Helicopter*, February, 1946, pages 13, 28, 30.

Is the Helicopter Ready? Igor I. Sikorsky. Advances in the art of flight during the last decade, including the development of the helicopter, are briefly outlined. The performance of present-day helicopters and the uses to which they may be put are discussed. How a helicopter was employed to rescue a Royal Canadian Air Force plane that was stranded in the Labrador wilderness is recounted. Remarks are made about possible future trends in helicopter design. *Air Transportation*, January, 1946, pages 18, 20, 21, 3 illus.

Stress Analysis

Stability of Semimonocoque Wing Structures. Henry L. Langhaar. The Consolidated Vultee Aircraft Corporation recently built and tested several cambered box beams that were structural models of stressed-skin airplane wings. It was found, as a result of these tests, that plate-stringer column-fixity factors of the specimens ranged from 1.00 to 3.00. These observations are rather revealing in view of the frequent arguments among stress analysts concerning the correct fixity factor to be used for calculating allowable plate-stringer loads. It is therefore especially satisfying to find that the test data are in harmony with a simple approximate theory of elastic stability of wing structures. This theory exposes the possibility of occasionally exerting control over fixity factors for purposes of weight economy or bulkhead rearrangement. It further suggests modifications of wing construction, such as the substitution of shallow ribs for bulkheads in highly cambered wings. *Journal of the Aeronautical Sciences*, March, 1946, pages 119–125, 4 illus.

A Procedure for Determining the Critical Load for a Column of Varying Section. G. H. Martin. This paper presents an approximate method for determining the critical load for a pinned end column of varying cross section. Although there are various procedures available for obtaining a solution to the problem, the writer believes that the application of the method suggested is simpler in principle and that it requires relatively less calculation for the degree of accuracy obtained.

The following examples of pinned end columns have been solved in the paper: (1) columns of constant section, (2) symmetrical columns of varying section, and (3) unsymmetrical columns of varying section. *Journal of the Aeronautical Sciences*, March, 1946, pages 135–140, 13 illus.

The Stress-Area Method Applied to Frames. Gilbert C. Best. A procedure is worked out to facilitate the design of frames. The necessary alterations in frame section moments of inertia to obtain predetermined stresses at given points are evaluated. The principal saving of labor is due to the use of original frame sections—the added material being considered removed and replaced by loads causing identical stresses throughout the structure. An example problem is given illustrating the method. An appendix gives additional proofs to the relation between section changes and equivalent moments and an extension of the stress-area method. *Journal of the Aeronautical Sciences*, March, 1946, pages 151–155, 1 illus.

The Flutter of a Uniform Cantilever Wing. Martin Goland. By integration of the differential equations for the wing motion, the flutter speed of a uniform cantilever wing (one with a built-in root and with constant mass and stiffness characteristics along its entire span) is determined. The solution is free of the dynamic approximations usually made during flutter analyses of the Rayleigh-Ritz type. A brief discussion of the procedures conventionally employed for the solution of the flutter problem is given, followed by a detailed derivation of the exact method for finding the flutter speed. It is found that a Rayleigh-Ritz type analysis, based on the fundamental uncoupled bending and torsion modes, is entirely adequate for the flutter analysis of a uniform wing. In addition to yielding a flutter speed that is in excellent agreement with the true value, the approximate method adequately predicts the wing shape at flutter. Additional parts of the paper deal with the relation between the uncoupled and the ground modes for the uniform wing and with the nature of the wing response resulting from forced excitation while in flight. *Journal of Applied Mechanics*, December, 1945, pages A-197–A-208, 11 illus.

Circular Bulging of Aluminum-Alloy Sheet at Room and Elevated Temperatures. George Sachs, George Espey, and G. B. Kasik. The paper reports preliminary results of tests of the strength characteristics and forming limits of various grades of aluminum-alloy sheet, subjected to hydraulic pressure over a circular area at temperatures up to 500°F. The strain distributions were analyzed by means of a photogrid after these bulges failed. The bulges exhibited a practically balanced biaxial strain state over most of the contour with the exception of a narrow range of local deformation in the vicinity of the fractures. The maximum meridional strain outside the necked area observed at the pole of a bulge, in spite of its biaxial nature, generally exceeded the uniform elongation known from tensile tests. The forming limits for all annealed conditions increased considerably with increasing temperature if the temperature exceeded a certain critical value, between 250° and 400°F., depending upon the alloy. The heat-treated conditions of the alloys 24S and 61S were only slightly affected by the testing temperature, while the forming limits (uniform stretch) of 75S-T, R301W, and R301T were materially increased at elevated temperatures. The reduction of thickness,

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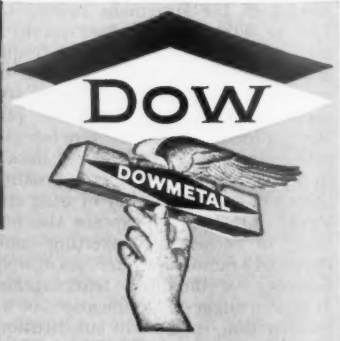

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which is a measure of the ductility of an alloy, followed approximately the same trend as the forming limit. *Transactions of the A.S.M.E.*, February, 1946, pages 161–173, 25 illus.

Parallel Columns with Common Lateral Supports. H. L. Langhaar. Problems in the stress analyses of semimonocoque aircraft structures have suggested the investigation of the stability of a system of closely spaced, equally stressed, parallel columns with lateral bulkhead supports. The theory presented establishes a correlation between this problem and the problem of stability of a single column with lateral spring supports. Since the theory for the latter case has been developed by several authors, the correlation effects a solution of the more general problem. *Journal of Applied Mechanics*, December, 1945, pages A-253–A-256, 1 illus.

A Graphic Resolution of Strain. N. J. Hoff. A purely graphic procedure is developed for the resolution of strain data obtained from measurements by strain rosettes of any shape. The characteristic features of the procedure are: (a) The diagram is constructed directly from the measured data, without necessitating addition; (b) strains are represented by distances measured in the true directions; (c) the true directions of principal strain are shown; (d) the true sense of rotation of straight lines is shown. The development of the procedure affords a purely geometric proof of the representation of the state of two-dimensional strain by Mohr's circle. *Journal of Applied Mechanics*, December, 1945, pages A-211–A-216, 12 illus.

Circular Calibration Ring with Two Axes of Symmetry. Given Brewer. The writer describes a method for accurately determining the deflection of a circular calibration ring having two axes of structural and loading symmetry. He develops equations that are based on the effect of transverse stress on the effective modulus of elasticity, the influence of curvature on the effective moment of inertia, and the elastic energy resulting from axial and shear forces. *Product Engineering*, February, 1946, pages 115–119, 13 illus.

A Graphical Method for the Evaluation of Principal Strains from Normal Strains. Glenn Murphy. The writer refers to graphic methods that have been developed for determining the principal strains when the observed strains are measured along gage lines that make angles of 45° or 60° with each other. He then presents a simplified graphic method for the general case in which angles between the gage lines may have any arbitrary values. *Journal of Applied Mechanics*, December, 1945, pages A-209, A-210, 1 illus.

Tension Tests at Constant True Strain Rates. C. W. MacGregor and J. C. Fisher. Tension tests of the true stress-strain type are reported for which the true strain rate is maintained constant throughout each test. Several metals are investigated under testing temperatures ranging from −183° to +665°C. The influence of temperature and strain velocity on the true stress-strain properties is described. A single variable called the "velocity-modified temperature" is used to represent the combined influences of true strain rate and testing temperatures. *Journal of Applied Mechanics*, December, 1945, pages A-217–A-227, 32 illus.

Superchargers

The Influence of Tube Shape on Heat-Transfer Coefficients in Air to Air Heat Exchangers. F. H. Green and L. S. King. The effect of tube shape on heat-transfer coefficients in aircraft-engine supercharger intercoolers is investigated. Heat-transfer coefficients are reported for air passing through round tubes, through partially flattened tubes, and through partially flattened tubes that have also been dimpled. It was found that flattened tubes maintained fully turbulent flow and, consequently, a higher heat-transfer coefficient at lower Reynolds Number values than did round tubes. The addition of dimples to the flattened tubes maintained fully turbulent flow from the transition point and increased the heat-transfer coefficient substantially. The addition of the dimples also improved the relation between heat transfer and pressure drop in the flattened tubes. *Transactions of the A.S.M.E.*, February, 1946, pages 115–122, 11 illus.

Seals for Preventing Oil Leakage in High Speed Superchargers. Zola Fox. A design engineer describes methods of preventing oil leakage through the openings for shafts in gear cases and bearing housings of high-speed superchargers where pressure differentials exist across the seal. The design and performance of ring, labyrinth, and contact types of oil seals are discussed, and their relative advantages are compared. Diagrams show assembly details of oil seals and poor, improved, and preferred designs of oil seals. *Product Engineering*, February, 1946, pages 158–162, 7 illus.

Testing

Nondestructive Etching Procedures. Mary F. Grondona and Stuart Martin. The article relates how the engineering test laboratories of an aircraft manufacturer undertook the task of establishing a reliable, nondestructive, and expedient means of aluminum-alloy segregation. The method developed was for the purpose of effecting a quick and nondestructive separation of aluminum alloys and their various tempers, merely by observing the results of a chemical reaction between a chemical reagent and the surface or edge of the material involved. In order to do this, it was necessary to develop chemical reagents that when applied to different materials would produce dissimilar reactions by position of the materials involved. In conjunction with such a test, it is considered necessary to determine the condition of the material by hardness tests. A chart shows the various etching procedures and the hardness values developed to identify the materials and their various tempers. *Aluminum and Magnesium*, February, 1946, pages 13–15, 1 illus.

Reversed Stress Testing of Piston Materials at High Temperatures to Determine Their Usefulness. The article is a translation of a paper published in October, 1943, at the Public Material Research Institute of the State College, Stuttgart, Germany, under the sponsorship of the Research Director of the German Aircraft Ministry and the Commanding Officer of the German Air Force. The writers, K. Wellinger and G. Staehli, describe tests carried out to establish comparative values that might serve as a rough estimate for the selection of piston alloys. Transitory inertia tests were carried out on aluminum alloys subjected to high temperatures in order to obtain reliable data on the entire strength-range of these alloys, with reference to their usefulness within this range for piston alloys. The test procedure and the testing machine used are described. Test results are summarized. *Automotive and Aviation Industries*, February 15, 1946, pages 20–23, 66, 8 illus.

Testing the Effectiveness of Self-Locking Nuts. J. A. Sauer. Four simple tests for determining the effectiveness of self-locking nuts are described. The equipment for carrying out the tests is outlined and the number of samples needed to give a satisfactory measure of performance is stated. The tests provide technical data to enable the user to select the proper fastening devices for each application. *Product Engineering*, February, 1946, pages 97–100, 5 illus.

Elementary Performance Testing. Part I. T. R. Loudon. First part of a serial article outlining methods by which operators and pilots can carry out certain elementary tests to check the performance of their airplanes. The article is directed particularly toward operators of the smaller and slower types of aircraft with fixed-pitch propellers and normally aspirated engines.

Included is a discussion of the temperature, pressure, and density factors to be considered in the performance calculations. The writer recommends the following procedures and advises how to go about conducting them: checking of controls, power plant, and instrument installations; determination of total starting ground weight at which tests are to be run; continuous adjustment of altimeter at 29.92 during tests, so that altitudes registered will be pressure altitudes above sea level; checking of the stalling speed; and determination of the "position error" of the air-speed indicator. Readings to be taken are listed as those of the air temperature, altimeter altitude of test run, time over the course, indicated air speed of the run, and r.p.m. as a check on engine operation. *Canadian Aviation*, February, 1946, pages 48, 50, 1 illus.

Radio-Controlled Dynamic Model Augments Hydrodynamic Research. Ernest G. Stout. The Staff Engineer in Charge of Hydrodynamics at the Consolidated Vultee Aircraft Corporation reveals details of the design, development, operation, and functions of a radio-controlled free-flight model airplane that is used for the study of a seaplane's dynamic characteristics during take-off and landing. The model features a two-cycle, twin-cylinder opposed-type gasoline engine, displacing 2.77 cu.in. and weighing 3.4 lbs., and scale duplicates of the full-scale flying boat's Curtiss electric three-bladed propellers. Supplementing the information about the model itself are details about the radio receiver and transmitter that control its operation. In addition to being a means of establishing stability criteria, it is stated that this equipment can be used for all forms of hydrodynamic research, such as hydrofoil studies, hull forms, auxiliary sustention, and high-lift devices; accurate determination of the effects of modifications to existing flying boats; helping to reduce the time from conception to production of the full-scale airplane. *Aviation*, February, 1946, pages 171–173 3 illus.

Tools and Equipment

Gauge and Tool Exhibition. A survey of the British precision equipment displayed at the January exhibition of the Gauge and Tool Makers' Association. Specific items reviewed include a matrix thread grinder; angle-gage dividing head; optical dividing head in which the reading is projected onto a small glass screen; toolmakers' microscope; machine for multidimensional, completely automatic sorting; air-operated gage, capable of checking simultaneously six dimensions on the component to be measured; and a Revlac universal vibrating machine. Other units surveyed are a special form miller for the machining of a large variety of small milling cutters; Braille reading micrometer; and a Sinometer, a device for the comparative measurement of angles to within 30 sec. of an arc. *Aircraft Production*, February, 1946, pages 81–84, 10 illus.

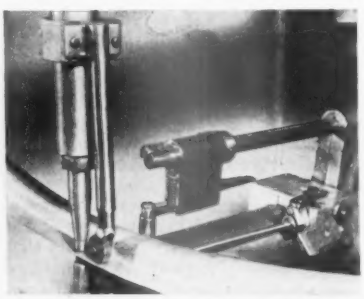
New Profile Projector. The construction, design, operation, and applications of a profile projector recently introduced by Taylor, Taylor and Hobson, Ltd., are noted. A development of the firm's earlier Model 200 projector, the new instrument can magnify objects up to 6 in. in diameter by ten times. In addition to a description of the projector, the brief article contains a table of collimations for the standard optical systems available for use with the projector. *Flight*, January 31, 1946, page 117, 1 illus.

New Assembly Process. Features and advantages of a new self-locking fastening device are outlined. Designed to combine the merits of a bolted assembly with the speed, lightness, and economy of riveting, the Hi-shear stop-pin method of fastening is credited with the following advantages: The shear value equals that of a similar size of high-tensile bolt; the weight is approximately one-third of that of a bolt-and-nut assembly. Conventional riveting equipment may be easily adapted to apply the fastener, and a simple tool provides for easy removal. It is made to standard bolt sizes and is therefore interchangeable and is self-locking and automatically installed at the correct tension. The stop-pin is made of alloy steel and is provided with a malleable collar that is forced into the groove at the end of the pin to secure the assembly. *Aircraft Production*, February, 1946, page 94, 2 illus.

Variable-Angle Machining. Accompanied by diagrammatic interpretation, this is a study of the design, application, and operating principles of a special type of planer tool-box developed for the machining of a continually varying angle on aircraft spar-location blocks. In designing the box to meet the need for producing Hawker Tempest spar-booms to a continually varying angle to suit the changes of the airfoil section of the wing, a datum was taken at the point that was the origin of the variable angle on the boom. The point was made to coincide with the cutting point of the tool when set at correct height in the box for machining, and the box itself was designed to swivel in the vertical plane in a circular tenon slide about the same point. In this way a fixed datum was established for any angle of inclination of the box. In addition to being swivel-mounted, the toolholder can be traversed by means of a screw across the box on a horizontal slide. *Aircraft Production*, February, 1946, pages 101, 102, 3 illus.

Training

Halton School. An outline of the history and functions of the Halton School, training base for R.A.F. aircraft apprentices. The information related also tells of the physical setup of the school, its course of training, entrance requirements, and the future work for which it qualifies graduates. *Flight*, January 31, 1946, pages 118, 119, 4 illus.



Photograph Courtesy Rohr Aircraft Corporation

In welding at speeds in excess of 120 spots per min. an edge gage and indexing device are essential for the production of good work.

Welding

The Surface Preparation of Aluminum Alloy Sheet for Spot Welding. R. A. Wyant, D. J. Ashcraft, T. B. Cameron, and K. H. Moore. Recent experiments dealing with the surface preparation of aluminum-alloy sheet for spot welding are described in a progress report on aircraft spot-welding research. The investigation was conducted at the Rensselaer Polytechnic Institute. The effects of factors associated with precleaning, rinsing, and heat-treatment are discussed, and the stability of surface films is investigated. The results of electron-diffraction studies are reported. *The Welding Journal*, February, 1946, pages 65-s–76-s.

High-Speed Spotwelding. Bernard Gross. The possibility of applying spot welding to high-speed operation is considered. The writer discusses some of the factors that must receive careful attention to assure successful high-speed production, including machine design, tooling, setup, maintenance, and training of personnel. Tools and equipment essential for the production of good work at high speeds are illustrated. *The Iron Age*, February 21, 1946, pages 52–55, 7 illus.

Metal Flow and Fillet Formation in Brazing Aluminum. Mike A. Miller. The third article of a series further discusses the fundamentals of the aluminum brazing process. The first and second papers on the subject were published in 1941 and 1943, respectively. Size-and-shape factors of fillets formed in various capillary environments are considered, and a number of relationships are established by a trigonometric evaluation of the data. It is shown that aluminum brazing alloys are inherently fillet formers. The technical surface tension of several filler materials are determined by measurements of the size and shape factors of two vertical competing fillets. Practical applications of the results obtained in this study are discussed in relation to the design of joints for aluminum brazing. *The Welding Journal*, February, 1946, pages 102-s–114-s, 23 illus.

Tension Tests of Single-Row Spot-Welded Joints in 24S-T Alclad Aluminum Alloy Sheet. R. Della-Vedowa. The article describes the test procedure used in an investigation of the tension-strength characteristics of single-row spot-welded joints in 24S-T Alclad aluminum-alloy sheet and gives the results of the tests. The tests indicate that the tension strength of spot-welded joints increases as the weld spacing decreases until the point is reached where the weld nuggets touch. At spacings less than this, the tension strength decreases as the weld spacing decreases. The tension strength does not appear to be affected by differences in nugget penetration for welds of the same diameter. The reduced basic sheet strength, however, is less for welds with greater nugget penetrations. Small welds at

close spacings produce joints of higher tension strength than large welds at close spacings. *The Welding Journal*, February, 1946, pages 115-s–122-s, 15 illus.

Miscellaneous

Aviation's 1946 Yearbook. This annual directory is divided into fourteen sections. The first contains engineering data on American personal aircraft, showing drawings and photographs of the planes. The second section includes similar information for American, British, and Canadian transport aircraft; the third, for American and foreign bombers; the fourth, for American and foreign fighters; and the fifth, for American guided missiles. Sections six, seven, and eight consist of American engine specification tables, American aircraft specification tables, and foreign aircraft specification tables. An illustrated section of American helicopters is followed by a group of helicopter specification tables. American and foreign turbojet specification tables are given in section eleven. The twelfth section is a directory of key personnel of American aircraft and helicopter manufacturers; the thirteenth, a compendium of illustrated descriptions of accessories and field units; and the fourteenth, an expanded sketchbook of design detail. *Aviation*, February, 1946, pages 87–169, 259 illus.

Construction and Operations Issue. The February issue of *Aviation Maintenance & Operations* contains a special study of the planning, construction, and operation of airports, and air service operations. The first section deals with airport planning and the layout of landing and service facilities. The section on airport construction takes up such matters as costs, clearing, grading, and turfing the land; field lighting and fueling systems; and plans for buildings, communications, marking, seaplane bases, and field equipment. The section on airport operations supplies information and data about airport revenues, management and policies, service facilities, commercial operations, inspection, repair stations, and field lighting.

Aircraft service operations are dealt with in sections outlining the services performed by the operator, the operation of shops and sales agencies, flight instruction, rentals and charter services, and other revenue-producing activities. The articles are accompanied by numerous sketches, plans for airport layout and lighting, charts and tables of data. A bibliography of Government publications, books, trade magazine articles, and manufacturers' publications is included. *Aviation Maintenance & Operations*, February, 1946.

Engineering Evolution from War to a Peacetime World. L. K. Sillcox. Recent progress in the different fields of engineering is reviewed. The article includes sections devoted to advances in aircraft design, gas turbines, and jet propulsion. The progress made in metalworking and quality control is discussed. Developments in plastics and the National Emergency steels are outlined. *Mechanical Engineering*, February, 1946, pages 101–106, 138.

P.A.D. An article on the Pilotless Aircraft Division of the Naval Aircraft Modification Unit relates the functions of this Division, briefly reviews its establishment and development, and describes some of the devices it has originated. The opinion of the officer in charge of P.A.D. as to how American pilotless aircraft compare with those of the Germans is reported.

As summarized in the article, the functions of the P.A.D. are to develop automatic glider tow, radio-controlled gliders and target drones; to test guided missiles designed by the Bureau of Ordnance; and to test pilotless devices procured by the Bureau of Aeronautics from private manufacturers. Among the devices surveyed are (1) "Little Joe"—a radio-controlled, antiaircraft guided missile that can be launched either from the surface or from the air; (2) the bat—a Bureau of Ordnance radar target-seeking glide bomb; (3) the LBT Glomb—a glider bomb towed behind an airplane and equipped with an automatic glider-tow device; (4) the LBE Glomb—similar to the LBT, radio-controlled, and equipped with television; (5) the Gorgon—a canard-type rocket-propelled pilotless aircraft, equipped with television and controlled by radio; (6) KDD-1—a reaction-propelled, all-metal target drome; (7) KDN-1—a radio-controlled drone powered by a turbojet engine developing 225 lbs. of thrust; and (8) Gargoyle—a high-angle, radio-controlled, guided dive missile capable of a speed of 650 m.p.h. *Air Trails*, March, 1946, pages 40, 41, 116–118, 12 illus.

Contact Lenses for Pilots. Sgt. Ralph E. Flexman. Contact eye lenses are advocated for pilots requiring ocular correction. The merits of contact lenses for the particular visual needs of pilots are indicated, and comments are included as to the qualities and wearability of this type of eyeglass. *Air Facts*, March, 1946, pages 48–50.

The Atom and Aviation. William F. Ogburn. Effects of atomic energy upon future aviation developments are envisioned. The discussion pertains mainly to two possible trends: first, the use of atomic energy to power aircraft; and, secondly, the effects upon aviation if the threat of atomic bombing forces the decentralization of major cities. The first expected use of atomic energy in aviation is stated to be in the form of an atomic bomb carried by a rocket that is propelled by other means. *Flying*, March, 1946, pages 21, 82, 84.

Plan Now to Attend National Meetings

LIGHT AIRCRAFT MEETING

June 13–14, 1946 — Horace H. Rackham Educational Memorial — Detroit, Michigan

SUMMER ANNUAL MEETING

July 18–19, 1946 — The Hollywood-Roosevelt Hotel — Los Angeles, California

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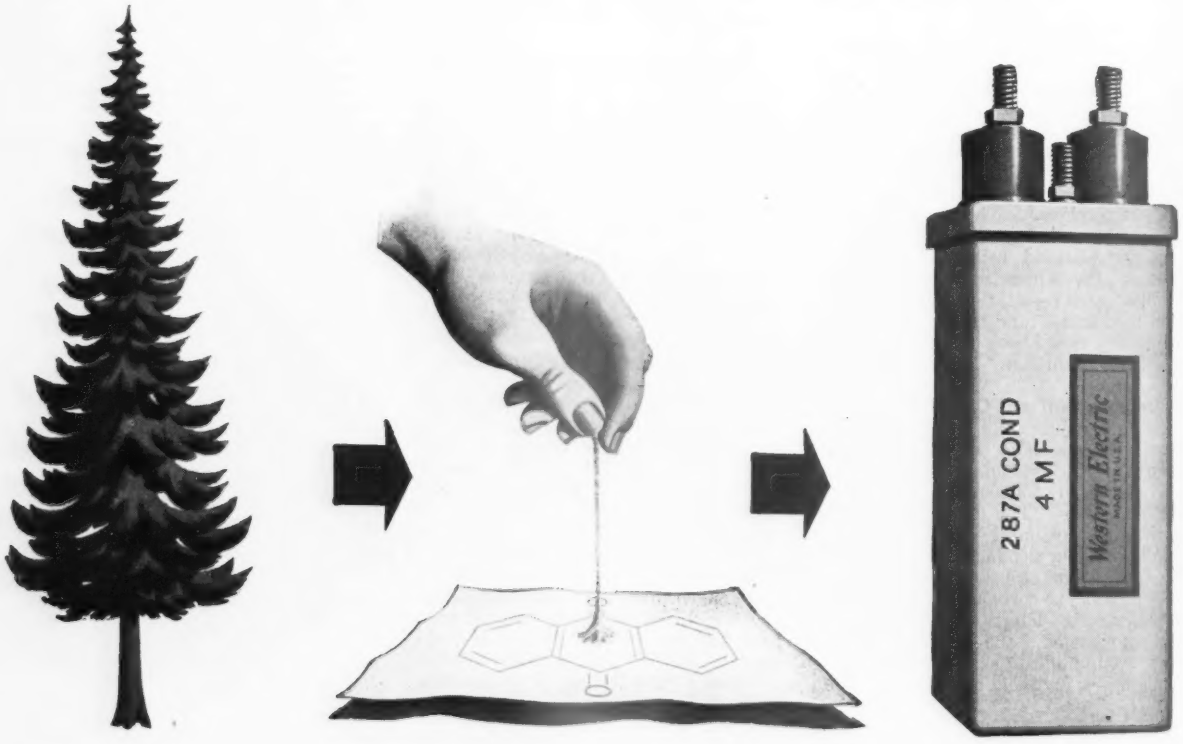

CRUCIAL links in every wire and radio system are paper capacitors — rolls of impregnated paper and metal foil. At least one is in every telephone — and more than 100 million are in the Bell System. A single failure can sever a telephone call, put a costly line out of service. So finding out how to make capacitors stand up longer is one of the big jobs of Bell Telephone Laboratories.

All-linen paper was once the pre-eminent material. Then wood pulp was tried — and found to last longer under heat and direct voltage. But why? Something in the wood was helping to preserve life. What was it?

Ultra-violet light, delicate micro-chemical analysis and hundreds of electrical tests gave a clue. Researchers followed it up—found the answer by treating the impregnated paper with anthraquinone—a dye intermediate. A mere pinch of the stuff prolongs capacitor life by many precious years.

When war came, great quantities of capacitors were needed for military equipment, where failures could cost lives, lose battles. The Western Electric Company, manufacturing for the Bell System, willingly disclosed the life-preserving treatment to other manufacturers. Today in communication capacitors, the new "life-extension" is helping to give more dependable telephone service.

Day by day, resources of this great industrial laboratory are being applied to perfect the thousands of components which make up the Bell System.

BELL TELEPHONE LABORATORIES *EXPLORING AND INVENTING, DEVISING AND PERFECTING FOR CONTINUED IMPROVEMENTS AND ECONOMIES IN TELEPHONE SERVICE.*

Government Publications

Army Air Forces

Mission Accomplished. The highlights in the career of General of the Army H. H. Arnold, retiring Commanding General of the Army Air Forces, are traced in a brief biographic sketch. The review is accompanied by pictures showing some of the important events in the General's life, from his enrollment at West Point in 1903 to his receipt of two additional oak-leaf clusters for his Distinguished Service Medal, from President Truman, who cited General Arnold's "great personal leadership, driving spirit, and professional genius." *Air Force*, January, 1946.

First "Push-Button" Flights. What is described as the first "push-button" flight—fully automatic from take-off to landing—was made possible by the development, by Air Technical Service Command designers and engineers, of a mechanical device called the Automatic Flight Controller. The first of these units, installed in a Douglas C-54 Skymaster four-engined transport plane, is now being tested at the All Weather Flying Center, Columbus, Ohio.

The Automatic Flight Controller, which is used in conjunction with the A-12 Automatic Pilot, is described as a coordinated system of aircraft controls whose functions can be preselected to produce a desired point-to-point flight, including automatic take-off and landing. It is this preselection feature that differentiates the Automatic Flight Controller from previously developed systems of flight control, such as a radio-controlled plane that is directed by remote control either from the ground or from a "mother" aircraft, since "push-button" flight is completely controlled by a system of automatic devices installed in the airplane itself and operating independently of any outside director or control. Thus, for example, it becomes possible with the Automatic Flight Controller, after taxiing the plane into take-off position at Wright Field, to press a button marked "La Guardia Field," and without further manipulation of any controls the plane will take off, climb to predetermined altitude, find and fly the preselected directional beams, arrive, and land at the destination selected.

The nerve center of the Automatic Flight Controller is known as the Master Sequence Selector. The Master Sequence Selector receives signals representing the variable factors such as direction, distance, and altitude, and it

then delivers impulses motivating in proper sequence the mechanical functions of the airplane.

Preparation of the plane for fully automatic flight consists simply of placing the plane in position on the selected runway heading, with brakes locked and engines idle. At this stage the only manual operation is performed—pushing the button that activates the Automatic Flight Controller—and this unit then takes over completely all direction and operation of the plane. Take-off procedure is initiated by automatic advancement of throttle, the brakes are unlocked after 8 sec., and the aircraft takes off.

At 800 ft. the pressure stat operates to move back the throttle, the wheels are retracted, the flaps are raised automatically, and the aircraft climbs to cruise altitude. The pressure stat again operates and the throttle is moved back for cruise speed, the magnetic heading control is cut in, the air log starts counting air miles, the aircraft begins flight in the correct direction, and the automatic altitude controls are cut in. Upon approach to destination, signaled when the air log runs down, the autopilot "homes" on the selected radio compass station. When passing over the cone-of-silence marker the throttle is automatically cut back, the automatic pilot being controlled by a compass locator station at the outer marker. A down signal is fed into the elevator-control circuit, and the aircraft "homes" on the outer marker and loses altitude in an inbound position.

Upon reaching an altitude of 880 ft. the pressure stat initiates the automatic operations to lower landing gear and flaps, cutting back the throttle and cutting in the automatic altitude control, with the aircraft still homing on the locator station.

As the aircraft passes the outer beacon marker, the elevator control is operated by the glide-path signal. As the wheels touch the landing strip, the throttle automatically cuts back. Brakes are applied automatically after a delay of 3 sec., while ground direction is controlled by a differential braking system until the aircraft comes to a full stop. *Air Technical Service Command.*

Airpower . . . and the Kitchen Sink. T/Sgt. Douglas J. Ingells. The writer reviews at considerable length the development of military aircraft during the war, with comments on the production and accomplishments of various types of fighters, bombers, trainers, cargo planes, transports, gliders, helicopters, and others. Sections of the article deal with quantity production of aircraft, the development of jet propulsion, wartime research concerning radar, and the work of the Air Transport Command. How the technical advances perfected in the war can be applied to civil aviation is emphasized. *Air Force*, January, 1946.

Models, Maps, and "Mock-Ups" Aid A.T.S.C. Battle Against Weather. Pilots of the All Weather Flying Division of the Air Technical Service Command fly missions at least once in every 6-hour period of every day to "look for trouble" by seeking out and flying into the worst weather conditions accessible by plane from their base. The purpose of these flights is to find adverse weather, study its effects on plane performance, and record such effects so that it will become possible to find methods or equipment to neutralize them.

The airplanes flown on these missions are virtually air-borne weather laboratories, manned by meteorologists, engineers, and especially trained pilots. The planes are equipped with many of the standard instruments used by weather forecasters, as well as especially designed devices particularly suited to meet the requirements of all-weather flight operations.

After it is determined in actual flight tests that an instrument has proved effective in combating weather conditions or promoting safety in all-weather flying, a further problem is posed in determining the proper location for the new instrument on the cockpit control panel. Exhaustive study and tests are devoted to the problem, for proper location of the instrument is vital in effecting greatest efficiency in pilot operation and safety.

To facilitate study of this subject by engineers, technicians, and pilots, mock-ups or actual nose sections of aircraft, complete with installations of all con-

trols and instruments, are set up in a hangar of the Division. This unusual combination of laboratory and museum includes mock-ups duplicating in every respect the nose sections of the P-61, C-46, B-17, B-29, C-47, and C-54, all salvaged from aircraft marked for scrap.

Another valuable aid is an unusual type of map used by the All Weather Flying Division. Graduated and divided with glass inserts and slides upon which are drawn cloud and weather conditions prevailing in the area depicted, the map gives almost at a quick glance a comprehensive picture of weather conditions existing at the moment. It also reveals weather conditions as they will be at any moment along the entire route of flight, thereby enabling the pilot to project his flight plan, before taking off, in such a manner as to be forewarned and prepared for any weather conditions to be encountered.

Still another type now under construction is a relief or modeled-terrain map. This is an exactingly executed model of the terrain surrounding the airport for a radius of 10 miles and is built to the scale of 1 ft. to the mile, with elevation scaled 1/4 in. to 20 ft. Upon completion, the terrain model will serve as a visual aid in briefing pilots for instrument-approach landings, with a resultant increase in safety that comes through knowledge on the part of the pilot concerning his whereabouts in relation to the landing runways. A terrain map of this kind also serves in aiding engineers and technicians to determine the best location for beacons, markers, and radar sites, effectively increasing the efficiency and benefit of these devices for landing and control operations. *Air Technical Service Command.*

Republic Aviation Corporation's XP-84 jet fighter. The plane is powered by a new axial-flow General Electric jet propulsion unit and was designed and built under the joint supervision of the Republic Aviation Corporation and the Air Technical Service Command. Although its performance details have not been revealed, its first test flight indicated excellent flying characteristics.

Civil Aeronautics Administration

Practical Air Navigation. Thoburn C. Lyon. The second edition of a text on aerial navigation, in the form of a Civil Aeronautics Bulletin, is, in effect, the fifth edition, since the first three were issued as a Special Publication of the U.S. Coast and Geodetic Survey. The present edition has been completely revised by the original author, the Chief Cartographic Engineer, Aeronautical Chart Branch, U.S. Coast and Geodetic Survey. Several new chapters have been added, bringing the text up to the date of revision by including the latest developments. Information with regard to certain methods and equipment has been limited by prevailing considerations of national security.

The first chapter deals with the problems of aerial navigation, touching upon flight and the aircraft, aids to navigation, air-traffic control, communications, and charts. The second chapter contains a study of the forms and features of the earth, explaining the measurements of distance and time. Various projections used in air navigation are the subject of the third chapter. Instruments, including the usual flight instruments and those designed for navigation, are discussed in the fourth chapter. Chapter V shows how to read charts, and the sixth and seventh chapters give instructions relative to a dead reckoning. Air-navigation computers are treated in the eighth chapter.

Chapter IX contains detailed explanations of radio navigation, while methods and instruments used in celestial navigation are thoroughly expounded in the tenth chapter. The special problems involved in air routes over the North Pole are studied in Chapter XI, with comments about the particular difficulties affecting flight navigation in the North Polar regions. Chapter XII gives practical hints about the work of air navigation, with sections about contact flying and instrument flying. A typical flight is followed, showing how the pilot keeps in communication with the airway-traffic control facilities.

Appendixes contain lists of abbreviations and symbols, a glossary of the principal navigational terms, and a list of aeronautical charts and publications of the Civil Aeronautics Administration. An envelope attached to the back cover of the book contains sample charts. *Civil Aeronautics Bulletin No. 24.* For sale by Superintendent of Documents, Washington, D.C., $1.00.

Transition to VHF Radio. How the transition to very high frequency radio will be effected and the beneficial results of the change for private pilots are outlined in connection with a review of the activities of the Civil Aeronautics Administration's Experimental Station at Indianapolis. It is stated that the change will be made gradually, without interference with existing equipment and operating routines. The new omnidirectional range, improved instrument-landing systems, and communications equipment are described, and the advantages to all classes of flight operations are summarized. *Office of Aviation Information.*

Agreement on Federal-State Jurisdiction. A two-day meeting of representatives of the National Association of State Aviation Officials and the C.A.A. resulted in definitions of the division of authority between the Federal and state governments on the problems of "policing the air" and punishment for reckless operation of aircraft.

The conferences agreed that the C.A.A. will continue to enforce the regulations concerning airworthiness of aircraft, competency of airmen, operating standards, and air-traffic rules, with the states cooperating in administering punishment for the reckless operation of aircraft in their jurisdiction.

The states will supplement the C.A.A. enforcement of safe-flying practices and will have the power to "ground" the flier through court action. If the local court believes that the penalty should be greater than 30 days, it is recommended that the court inform the Civil Aeronautics Board immediately through the C.A.A. so that the pilot's continued competency may be examined.

The C.A.A. agreed that the states, if they so desire, may require the registration of aircraft and pilots if: the pilot registration fee is nominal; the aircraft registration fee is moderate; and, where personal property taxes exist, it is in full substitution for all state, county, and municipal property taxes on the aircraft. Possession of the appropriate effective Federal certificates and payment of the prescribed fees shall be the only requisites for state registration. It was further agreed that the penalty for failure to register under state laws should be a reasonable fine or term of imprisonment but not "rounding."

Court actions on reckless flying should be recorded on the pilot's state registration certificate.

The C.A.A. reaffirmed its position that it is the states' function to license airports, and the state officials presented for consideration and later action a list of standards to be applied to airports of less than Class 1 size and operated commercially, as well as minimum facilities that should be required at all commercially operated airports.

During this discussion, the C.A.A. made it clear that the airport specifications in its Airport Design Manual were in no way intended for use as minimums but rather as guides to planning. In consequence, there was lengthy discussion concerning what minimums should be set up as a guide to state

officials charged with licensing airports, especially those smaller than the Class 1.

Minimum standards considered included landing-strip lengths of 1,500 instead of 1,800 ft., glide angles of 15 to 1 instead of 20 to 1, and wind coverage of 60 instead of 70 per cent. However, no agreement was reached, since it was the consensus that this was a matter that would have to be carefully studied by state officials, the Civil Aeronautics Administration, and other civil aviation interests so that any nationwide standards that might be agreed to would both safeguard the flying public and serve to develop the greatest possible number of small airports.

With regard to facilities required for state licensing, it was the consensus that such items as the following should be required of commercially operated airports: adequate fuel and oil; attendance or availability of a manager and airplane and engine mechanic; tiedowns or hangar space; wind indicator; fire-fighting equipment that meets underwriters' requirements; available airport-maintenance and snow-removal equipment; telephone, water, and restrooms; and first-aid kits.

Changes in the 1944 Uniform State Aeronautics Department Act were agreed upon, and the Act was referred to J. M. Hunter of the C.A.A. and Herzel Plaine, Federal-State Division, Department of Justice, for redrafting in accordance with the policies agreed to at the meeting and for early distribution. *Office of Aviation Information.*

Designation of Manufacturing Inspection Representatives. In keeping with the expansion of civil aviation and the development in the aircraft manufacturing industry of recognized standards of production and quality control which give assurance of safe, economical, and extensive service life in articles so manufactured and controlled, the Civil Aeronautics Administration considers this an appropriate time in which to initiate changes in the terms of production certification commensurate with the advancement achieved which will give qualified manufacturers greater responsibility and increased privileges.

These changes are directed toward a fuller realization of the original concept of a production certificate, whereby any qualified manufacturer (by establishing procedures, methods, and policies that will assure the production of reasonable duplicates of the aircraft, aircraft engine, propeller, or appliance for which a type certificate is held) will be granted certain privileges that will permit such manufacturers to produce, certificate when appropriate, and deliver articles manufactured under a production certificate without the necessity for inspection by the C.A.A. prior to certification.

To accomplish this end, each manufacturer currently holding a valid production certificate and each future Applicant meeting the requirements for such certificate and desiring to take advantage of the privileges extended under this policy may select and request the appointment of one or more qualified employees, to be known as designated manufacturing inspection representatives. This designee shall have the knowledge, experience, and judgment considered by the C.A.A. as essential to the handling of responsibilities hitherto assigned to C.A.A. aircraft-factory inspectors in determining the conformity and airworthiness of articles produced under the terms of the production certificate and in issuing documents pertinent to the certification of such articles. The appointment of the designated manufacturing inspection representatives will be initiated by a letter from the manufacturer to the regional office of the Manufacturing Inspection Division, through the responsible C.A.A. aircraft-factory inspector. This letter will be accompanied by a Statement of Qualifications, Form ACA 1381, executed by the nominee.

A detailed statement is given of the qualifications required of such designees and the conditions under which such appointments are to be made, suspended, or terminated. *Safety Regulation Release No. 195*, November, 1945.

Index to Current Releases. A revised list of Safety Regulation Releases previously issued which are in effect as of January 8, 1946, is contained in the current release. Omissions from the previous list represent material that either has been superseded or has since served its usefulness and may be discarded. The list gives the number of each release, the title, and the date. *Safety Regulation Release No. 197*, January, 1946.

Aviation for Teachers. A syllabus is offered as a study guide for elementary and secondary school teachers. It is not intended to be a text containing detailed and technical information. It is divided into units, each of which is introduced by a short statement, followed by a list of applicable books and other publications for supplementary reading. Questions for topics of discussion have been added, providing definite direction for each student in his quest for information.

The supplementary reading lists found in some of the units are intended for teachers who desire more detailed and technical understanding of aeronautical engineering. The reading lists have been selected so that the social, economic, and political implications of aviation are considered, as well as the elementary principles of flight. *Office of Aviation Training*, August, 1945.

RMS Value of Horizontal Field Pattern of UHF Two-Course Radio Ranges. H. W. Kohler. The problem treated is the determination of factors by which the field strengths of loop antennas, as obtained by a given method, have to be multiplied if the radiated power in the horizontal plane is to remain constant.

Determination of the total radiated power would involve integration of Poynting's vector over the hemisphere above ground, centered with the array. This difficult operation can be avoided by considering the field strength in the horizontal plane only. What may appear to be a rough method of arriving at the total radiated power is, from a practical point of view, quite satisfactory. Because of the counterpoise, relatively little high-angle radiation is obtained in the radio ranges considered, and for aircraft more than a few miles distant from the range station, the horizontal field strength is a fair approximation to the prevailing strength. The variation of field strength because of the interaction of direct and reflected waves does not need to be considered here. It is concluded that, when the power radiated in the horizontal plane is kept constant, the maximum strength and the field strength at 90° off-course remain constant and within 2 per cent in the practical range of current-ratio values. On the contrary, the field strength on-course decreases appreciably as the ratio decreases. For proper comparison of field strengths on-course with values of the given variables, the calculations must be made for constant radiated power in the manner described. *Technical Development Note No. 37*, June, 1945.

Effect of Parasitic Currents in Antennas of UHF Radio Ranges on Horizontal Field Pattern. H. W. Kohler. The purpose of this Note is to provide a qualitative picture of the effect of "parasitic currents" at field strength, course sharpness, and clearance of the horizontal field pattern. The term "parasitic current" as used in this Note designates antenna currents excited by mutual coupling (through space) between two or more antennas. Specifically, the case of three loop antennas present in the ultra high frequency radio ranges is considered. The parasitic currents produced in the side antennas by current in the center antenna are of interest.

No attempt has been made to analyze the complex nature of the coupling between loop antennas, especially since it is simple to measure relative magnitude and phase of the parasitic currents. As insufficient experimental data concerning the relationship between parasitic currents and their phase angle as a function of the tuning adjustments of the side antennas are available, a simple series circuit was assumed whose resistance is essentially the radiation resistance and whose reactance is varied by antenna tubing. *Technical Development Note No. 38*, June, 1945.

Development of the Ultra-High-Frequency Radio Range. Part III—A Visual-Aural Ultra-High-Frequency Radio Range with Simultaneous Voice. Part III of this report describes the development of an ultra high frequency two-course visual radio range with sector identification and simultaneous voice. It treats the basic principles of the various components of this type of range, such as the mechanical modulator, radio-frequency bridges, antenna systems, and tie lines.

The latter part of the report covers further simplification of the antenna system and various methods of applying simultaneous voice to this range. A navigational aid was developed which provided two visual courses and two aural courses to give sector identification, station identification, and a simultaneous voice feature for weather information and airway traffic control. The receiving and transmitting equipment that was used in this development is described, and the results of flight tests are given.

This radio range was developed to demonstrate improved methods in air navigation which would simplify the orientation problem. The field patterns are arranged so that the pilot is continuously informed as to the quadrant he is in by a combination of visual and aural indications. These principles were demonstrated and proved to be a great step forward in the simplification of the navigation problem. *Technical Development Report No. 49*, June, 1945.

CAA Equipment for Recording Airplane Take-Off and Landing Characteristics. Equipment has been developed by the Flight Engineering and Factory Inspection Division of the C.A.A., using the basic principle employed by the U.S. Army Air Forces by which an accurate time-space history of the take-off and landing characteristics of aircraft may be recorded and analyzed. By this means, the horizontal and vertical position, speed, and acceleration of aircraft may be determined at any and every point within the confines of a given runway. This equipment includes a motion-picture camera that simultaneously photographs a timing device and an aircraft on a runway, along the edge of which markers have been placed at definite intervals. A means of projecting these photographs, frame by frame, on a set of self-calibrating graduated scale blocks, so devised that horizontal and vertical distances may be read directly together with time, is also included in the equipment. Precision of the readings of time is about 0.005 sec. and of distances is $\frac{1}{2}$ ft. near the center and about 1 ft. near the ends of a 5,000-ft. runway.

A description of the installation and operation of this equipment is included in the report. The method of interpreting the records obtained therefrom and other pertinent information necessary to acquaint personnel with this equipment and its operation is outlined so that the personnel may satisfactorily set it up, operate it, and interpret records obtained therefrom. *Flight Engineering Report No. 4*, revised March, 1946.

The Apparent Effect of Pilot Technique and Atmospheric Disturbances upon the Measured Rate of Climb of an Airplane. A detailed report is made of an investigation undertaken to measure the rate of climb of an airplane by means of flight tests in such a way as to establish a single standard value representative of the actual performance of that type of airplane. The results of a number of successive attempts to measure the rate of climb under apparently identical conditions almost always produces as many different values of rate of climb as there have been attempts at measuring it. This result presents the problem of interpretation of the test results for the purpose of selecting the single representative value. The manner in which pilot technique may influence the rate of climb of an airplane would appear to involve primarily the selection of a proper air speed, the skill employed in maintaining this air speed, the manner in which the airplane is trimmed, and the selection and maintenance of proper settings for the power-plant controls. There also appears the remote possibility that the manner of application of the flight controls for the purposes of maintaining attitude and air speed may influence the result. For the purposes of flight testing, however, the air speed at which the airplane is to be flown and the power-plant control settings to be used are ordinarily arbitrarily specified. In the case of the normal operation of the airplane, the pilot is also informed concerning the use of the powerplant controls and the air speed for best rate of climb. For this reason, it has been considered appropriate during this investigation to eliminate the selection of a proper air-speed or power-plant control settings as variables indicative of pilot technique. Instead, the tests that have been conducted have all been flown at a single nominal value of air speed and power. The effect of pilot technique has, therefore, been reduced to that of the skill with which the other operations have been performed.

The entire test program involved two completely independent series of tests. The first series consists of 101 separate attempts, each by a different pilot, to measure the rate of climb in "smooth" air. The purpose of this series of tests was to eliminate atmospheric disturbances as far as possible in order to investigate the effect of piloting upon the measured rate of climb. For this reason, all of the tests in this series were conducted in clear air, free of any neighboring clouds and, wherever possible, above existing haze levels. At least 50 per cent of these tests were conducted in the absence of any clouds whatsoever. The remainder was conducted with scattered to broken cumulus clouds at least 2,000 ft. below the test altitude, with the exception that, in the case of a few of the tests, the cumulus clouds were at the same altitude as the test.

It is concluded that the mean value obtained from 101 separate attempts, each by a different pilot, to measure the rate of climb in "smooth" air agrees almost precisely with the previously measured performance of the airplane. The dispersion of the result of individual attempts from the mean value is apparently uninfluenced by the pilot to any appreciable extent but appears rather to be attributable to vertical motion of the atmosphere of such nature as to produce

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no sensation of roughness on the part of the occupants of the airplane. The results of 48 separate attempts (a majority by the same pilot) to measure the rate of climb in "rough" air indicated that the rate of climb is reduced by atmospheric roughness. While the amount by which the rate of climb is reduced increases with increasing roughness of the air, the rate at which climb is reduced tends to decrease with increasing roughness.

The results obtained in "smooth" air indicate that the odds are slightly in excess of ten to one that the mean value of five separate attempts to measure the rate of climb will lie within ± 15 ft. per min. of the most probable value of rate of climb which might be obtained as a result of an extremely large number of repeated attempts to measure it. *Flight Engineering Report No. 17*, May, 1945.

Radio Call Letters. One of six sections of Part IV of the *Federal Airways Manual of Operations, Volume III*. The manual contains a brief review of the system of allocation of radio call letters and gives lists of such calls letters, arranged alphabetically according to the call letter assigned to the station. Another list is arranged alphabetically according to the name of town or other community in which the station is located. *Federal Airways Manual of Operations, III-B-4-4, Communications Division*, February, 1946.

Civil Aeronautics Board

Carelessness—the Principal Factor in Ground-Fire Accidents. Harold B. Carr. Statistics concerning ground fires that occurred at airports are assembled in a Safety Bulletin. A brief outline of the results of fires is classified under the headings of welding, electric lamps, electric heaters, spray-cleaning with gasoline, engine backfire, matches and tobacco, and heating plants. Examples are cited under each category, and a tabulation summarizes the figures and percentages. The Safety Bureau's twelve recommendations for preventing fires are included. *Safety Bulletin No. 168-46*, February, 1946.

Combined Production and Resources Board

Report on Conference on Unification of Engineering Standards. The work of a joint committee, sponsored by the governments of the United States, the United Kingdom, and Canada, is reviewed in the report of the conference held in Ottawa, Canada, between September 24 and October 6, 1945. The report reflects the substance of the discussions held during the conference and records the achievements obtained up to that time. It includes the work accomplished in the period between the London Conference (held in August and September, 1944) and the latest meeting.

After giving excerpts from the opening remarks of the chairmen of the Conference and of the British and United States delegations, the report traces the activities of the consecutive sessions, which dealt with acme screw threads, buttress screw threads, high-duty studs in light alloys, unification of screw threads, and miscellaneous screw-thread forms. Further sections of the report detail the data agreed upon with regard to instrument screw threads, limits and fits in engineering, drawing practice, and pipe threads.

One session was given to a study of meteorology and mechanical engineering, and others dealt with screw threads and connection details for compressed-gas cylinders. Excerpts are included from various addresses made at a general meeting constituting one of the sessions. The text concludes with a bibliography and a tabulated list of the participants in the conference, and the appendixes contain tabulated data on the engineering standards agreed upon. *For sale by the Superintendent of Documents*, Washington, D.C., $0.20.

Department of Agriculture

Forest Products Laboratory Research Program 1945–1946. The research program of the Forest Products Laboratory for the fiscal year beginning July 1, 1945, is described, including individual projects and work planned during the year. The program deals with a wide variety of subjects relative to the development and use of wood products in many industries, including work having a bearing upon the use of wood products in aeronautical construction. *Department of Agriculture, Forest Service, Forest Products Laboratory*, Madison, Wis.

Department of State

The Defenses of Peace is the title of Part I of the report of the Chairman of the United States Delegation to the Conference in London in November, 1945, for the establishment of the United Nations Educational, Scientific and Cultural Organization. The booklet also contains the text of the final act of the Conference for establishment of the organization; the text of the constitution of the United Nations Educational, Scientific and Cultural Organization; the instrument establishing a preparatory educational, scientific, and cultural commission; and the text of the resolutions adopted by the Conference. A list of the delegates from the United States is appended. *Department of State Publication 2457, Conference Series 80*. For sale by the Superintendent of Documents, Washington, D.C., $0.10.

Treaty Developments 1944. The publication is designed to make available in convenient form the answers to many questions relating to treaties or other international agreements concerning which developments occurred during 1944. It is a compilation of data regarding signatures, ratifications, adherences, renewals, terminations, withdrawals, and other developments concerning such agreements. To complete the history of each agreement treated, information is included regarding similar developments prior to 1944. The document is divided into three parts, the first part containing information concerning treaties and other international agreements with respect to which developments occurred in 1944. Part II refers to such agreements that became effective with respect to the United States in 1944, and Part III refers to pending treaties and other international agreements with respect to which developments occurred within the year. The report is classified and indexed under a list of headings intended to make the information readily available. Among the sections are those dealing with civil aviation, air-transport services, and military and naval aviation missions. *Department of State Publication 2408*. For sale by the Superintendent of Documents, Washington, D.C., $0.10.

National Advisory Committee for Aeronautics

Correlation Between Strength Properties in Standard Test Specimens and Molded Phenolic Parts. P. S. Turner and R. H. Thomason. The report describes an investigation of the tensile, flexural, and impact properties of ten selected types of phenolic molding materials. The materials were studied to see in what ways and to what extent their properties satisfy some assumptions on which the theory of strength of materials is based—namely, (a) isotropy, (b) linear stress-strain relationship for small strains, and (c) homogeneity. The effect of changing the dimensions of tensile and flexural specimens and the span-depth ratio in flexural tests were studied. The strengths of molded boxes and flexural specimens cut from the boxes were compared with results of tests on standard test specimens molded from the respective materials.

The nonuniformity of a material, which is indicated by the coefficient of variation, affects the results of tests made with specimens of different sizes and tests with different methods of loading. The strength values were found to depend on the relationship between size and shape of the molded specimen and size and shape of the fillers. The most significant variations observed within a diversified group of materials were found to depend on the orientation of fibrous fillers. Of secondary importance was the dependence of the variability of test results on the pieces of filler incorporated into the molding powder, as well as on the size of the piece.

Static breaking-strength tests on boxes molded from six representative phenolic materials correlated well with falling-ball impact tests on specimens cut from molded flat sheets. Good correlation was obtained with Izod impact tests on standard test specimens prepared from the molding materials. The static breaking strengths of the boxes do not correlate with the results

of tensile or flexural tests on standard specimens. *Technical Note No. 1005*, February, 1946.

Stress-Strain and Elongation Graphs for Aluminum Alloy R301 Sheet. James A. Miller. The following properties were determined from tests on duplicate longitudinal and transverse specimens from aluminum-alloy R301 sheets with nominal thicknesses of 0.020, 0.032, and 0.064 in.: (1) tensile and compressive stress-strain graphs and stress-deviation graphs of sheet in the T condition to a strain of about 1 per cent; (2) graphs of tangent modulus and of reduced modulus for a rectangular section versus strain in compression of sheet in the T condition; (3) tensile stress-strain graphs to failure of sheet in the W condition and in the T condition; (4) local elongation and elongation versus gage length for tensile specimens from sheet in the W condition and in the T condition tested to fracture.

The stress-strain, stress-deviation, tangent-modulus, and reduced-modulus graphs are plotted on a dimensionless basis to make the results of a limited number of tests applicable to materials with similar stress-strain curves and with yield strengths that differ from those of the test specimens. An example is included to illustrate how these graphs may be used. *Technical Note No. 1010*, February, 1946.

Pressure Distributions for Representative Airfoils and Related Profiles. Theodore Theodorsen and Irven Naiman. Selected pressure-distribution diagrams for a number of conventional and special airfoils are presented. The conventional airfoils include the NACA 22-, 44-, and 230-series airfoils and the Clark Y family. The special airfoils consist of circular-arc sections of several thicknesses and curvatures and a number of synthetic airfoils, including several with zero moment coefficient. The pressure distributions are given in most cases for several lift coefficients, including that at the ideal angle of attack. *Technical Note No. 1016*, February, 1946.

The Synthesis and Purification of Aromatic Hydrocarbons. Part I—Butylbenzene. Joseph V. Karabinos and Joseph M. Lamberti. The synthesis and purification of aromatic hydrocarbons is part of a general investigation being conducted at the N.A.C.A. Cleveland laboratory on the evaluation of such compounds as antiknock blending agents for current aviation fuels. The investigation includes the aromatics from benzene through all of the possible structures with nine carbon atoms and some with ten carbon atoms. Several of the aromatic hydrocarbons were obtained from commercial sources and were purified by fractional distillation, fractional crystallization, or chemical means. The compounds that could not be commercially obtained were synthesized by the Organic Synthesis Section of the Fuels and Lubricants Division.

The present report, which is the first of a series dealing with the preparation of hydrocarbons for use in engine tests at the Cleveland laboratory, describes the synthesis and purification of a 13-gal. quantity of pure butylbenzene and presents physical properties of butylbenzene and 4-phenyl-1-butene. Because there is considerable discrepancy in the published matter as to the correct physical properties for the olefin, the position of the double bond was determined by ozonolysis. The synthesis described involves the preparation of 4-phenyl-1-butene and subsequent hydrogenation of the olefin to butylbenzene. *Technical Note No. 1019*, January, 1946.

The Synthesis and Purification of Aromatic Hydrocarbons. Part II—1,2,4-Trimethylbenzene. Earl R. Ebersole. A new method for the synthesis and purification of a 14-gal. quantity of 1,2,4-trimethylbenzene is described. This method consists in the chloromethylation of *m*- and *p*-xylenes, subsequent formation of ethyl dimethylbenzyl ethers, and hydrogenolysis of the ethers to yield the hydrocarbon. A yield of 35 per cent was obtained from a mixture of *m*- and *p*-xylenes, and a 25-per cent yield was obtained from commercial xylenes. Physical properties of the "best" gallon and of the engine sample of 1,2,4-trimethylbenzene are included. Evidence is presented for the existence of two crystalline modifications of 1,2,4-trimethylbenzene. *Technical Note No. 1020*, January, 1946.

The Synthesis of Methylenecyclobutane, Spiropentane, and 2-Methyl-1-Butene from Pentaerythrityl Tetrabromide. Vernon A. Slabey. Reduction of pentaerythrityl tetrabromide in ethanol with zinc in the presence of sodium carbonate and sodium iodide was found to yield methylenecyclobutane, spiropentane, and 2-methyl-1-butene. Yields were 46 per cent methylenecyclobutane, 21 per cent spiropentane, and 12 per cent 2-methyl-1-butene. The reduction procedure described offers a method of preparing both methylenecyclobutane and spiropentane from the same reaction in yields comparable with individual methods of synthesis previously reported. *Technical Note No. 1023*, February, 1946.

National Bureau of Standards

Recommended Commercial Standard, TS-4066—Sine Bars, Blocks, Plates, and Fixtures. The current draft of *TS-4066* is the result of conferences and correspondence with leading representatives of the industry, pursuant to initial request by the War Production Board and in accordance with subsequent desires of the trade. It incorporates a consensus of comment on a draft circulated on August 10, 1945, to producers and representative users, distributors, Government agencies, and testing laboratories.

Comment received indicates that a general conference for further adjustment is unnecessary at this time. Accordingly, this recommended commercial standard is being circulated to the trade for written acceptance so that it may become more widely effective through establishment as a commercial standard and publication by the Department of Commerce.

The purpose of this commercial standard is to provide minimum essential requirements for sine bars, blocks, plates, and fixtures as a basis for better understanding between sellers and buyers; for fair competition; and for identification of sine bars, blocks, plates, and fixtures conforming thereto. It covers the major essential requirements for such materials in commercial laboratory classifications, with particular reference to the 5-, 10-, and 20-in. sizes. *Division of Trade Standards.*

The New England Council

What New England Did in the War. A preliminary report for the year 1945 brings together estimates of the production of war material by various industries in New England. It shows that contracts for war supplies awarded to plants in New England between June, 1940, and June, 1945, amounted to a total of $17,760,000,000 and that of this total the value of aircraft and aircraft-parts contracts amounted to $4,467,000,000, or 25.2 per cent. It is noted that, in addition to the manufacturing activities of the region, air transportation was maintained despite the handicaps imposed by the shortage of personnel and equipment and that three of the nation's leading air lines expanded their services to include New England. *The New England Council*, Boston.

Office of War Mobilization and Reconversion

Battle for Production: Fifth Report to the President, Senate, and House of Representatives. The fifth report of the Director of War Mobilization and Reconversion is written in two parts. Part I is analytical and includes the major problems and policy questions. Part II is historical, reviewing the progress of reconversion and describing in greater detail the steps that have been taken and are being taken to effect a safe transition toward full peacetime production and employment. Numerous charts and diagrams illustrate the figures referred to in the text. *For Sale by the Superintendent of Documents*, Washington, D.C., $0.15.

The Port of New York Authority

World Air Route Planning. James C. Buckley. The Principal Economist of the Port of New York Authority has compiled a booklet of 20 pages outlining the application of the experience of the Authority to the work of planning international air-transport routes. The statistics include surveys of the air-traffic potentials available at New York, the effect on air-route proposals of pros-

pective foreign-flag competition, and problems of general policy. The study is supplemented by numerous maps, charts, and tables of dat

Public Health Service

Bibliography of Industrial Hygiene. Compiled by Ellen F. Bellingham, J. J. Bloomfield, and Waldemar C. Dreessen. The Industrial Hygiene Division of the Bureau of State Services has prepared a bibliography in response to a growing demand from industrial hygienists, governmental health and labor departments, the medical profession, industry, and labor for "a list of material on industrial hygiene." The selection of books, pamphlets, and articles has been guided by the requests of individuals and organizations for the literature in which they may find answers to particular problems—e.g., fatigue, carbon-monoxide poisoning, ventilation of plating tanks, hazards of foundry operations, responsibilities of industrial nurses, and successful methods of health education. The bibliography does not attempt to be a complete list or a list of "best books" but rather a reference list, each subject group a starting point for further study. Although the selection of material has been generally limited to items published before and during the year 1943, a few important papers have been included which appeared during the early part of 1944 while the bibliography was in preparation. The section on reference volumes is intended to be a guide in the selection of books for an industrial-hygiene library. Items considered to be of particular importance are indicated by an asterisk. Such books as foreign-language dictionaries and most general textbooks in fields relating to industrial hygiene have been excluded from the list, since each specialist knows the works in his subject and has his preferences. When there are several good books of a particular type available, such as medical dictionaries, one has been listed as a suggestion only. *Public Health Bulletin No. 289.* For sale by the Superintendent of Documents, Washington, D.C., $0.20.

Surplus Property Administration

The Liquidation of War Surpluses. The quarterly progress report to the Congress for the fourth quarter of 1945 summarizes the activities of the Surplus Property Administration for the period. It states that disposals, exclusive of the scrapping of nonsalable aircraft exceeded $500,000,000, representing a rate of almost four times the rate of disposal achieved in the third quarter. Nearly $233,000,000 was received for the property sold, equivalent to 43 per cent of its reported cost. Nonsalable aircraft valued at more than $1,000,000,000 were scrapped, and the metal was stored as a source of strategic materials. However, the total of surplus property disposed of during the final quarter of 1945 was dwarfed by the incoming volume of surplus material, which was estimated at $7,600,000,000. The surplus property inventory at the end of the year was $10,100,000,000 of which $3,600,000,000 represented nonsalable aircraft and $1,100,000,000 represented surplus material located overseas.

A detailed report is made of the work of the Administration, classified according to the type of material dealt with. One section refers to the activities of the Administration in disposing of surplus aircraft and aircraft parts. After outlining the objectives of the aircraft-disposal program, the report considers the individual categories of tactical airplanes, transport planes, personal planes, components and parts, and foreign sales of surplus aeronautical equipment located in the United States. The text matter is supplemented by tabulations and charts.

Australian Council for Aeronautics

On the Concept and Properties of the Idealized Hydrodynamic Resistance. G. K. Batchelor. Wire gauzes are used in flow fields for many reasons, the most common being to render the velocity of a stream more uniform in space and time. The problem of the effect of gauze on a flow field has been approached by postulating an idealized hydrodynamic resistance that produces a local pressure drop in a specified manner. Local characteristics of the flow at the resistance are examined, and the field equations are set up. The problem of steady, nonuniform flow through a resistance is solved approximately, Collar's equation for the diminution of nonuniformity of flow being confirmed.

The major part of the paper is devoted to a study of the change in characteristics of turbulence in a uniform stream flowing through a resistance. It is shown that if the turbulence is initially isotropic, it loses this isotropy at the resistance. The longitudinal and lateral velocity fluctuations are found to be reduced by factors depending on the resistance. There are indications that the longitudinal scales of turbulence are changed by the resistance. Experimental confirmation of these results is stated to be desirable. *Report ACA-13,* January, 1945.

Wind Tunnel Tests on Ducted Contra-Rotating Fans. J. F. M. Scholes and G. N. Patterson. This report describes a series of wind-tunnel tests on a pair of ducted contrarotating fans. The fans were designed according to the theory developed in a previous report, and the tests were carried out to obtain a check on the theory and to discover any discrepancies. The theory is found to be reliable except where tip loss and the boundary layer in the duct invalidate it. In addition, some observations on the duct exit pressure have been made. *Report ACA-14,* February, 1945.

Elastic Vibration of a Fan. E. R. Love and J. P. O. Silberstein. In calculating those frequencies and modes of elastic vibration of an aircraft-engine-propeller system which are likely to be excited by periodic variations in the driving couple, it is usual to regard as rigid all rotating masses mounted on the crank and propeller shafts except the propeller blades. The question arose whether a cooling fan mounted (with gears) on the propeller shaft could also be regarded as rigid without introducing appreciable error. The report develops a method of calculating the effect, expressed as "impedance" at various frequencies, of such a fan on the vibration of the system.

The method is applied to the PF 100 fan for the Pratt & Whitney R-1839 engine, and graphs are obtained showing its impedance over a wide range of frequencies at two extreme driving speeds. The graph of impedance that the fan would have if rigid is found to approximate these only roughly over a limited range. Graphs of impedance are also obtained which assume the fan elasticity to the extent of two or three degrees of freedom, in order to decide whether the relatively simple analysis involved by such an approach gives sufficiently close approximations. The use of two degrees of freedom gives results not much better than assuming the fan to be rigid, but the use of three degrees of freedom gives fair approximation over most of the range needed for the engine-propeller system. The method gives the modes of vibration corresponding to each frequency studied and could be used if required to give an account of the relative distribution of stress in the vibration fan. *Report ACA-15,* March, 1945.

Grid Sandwich Panels in Compression. F. A. Dale and R. C. T. Smith. The strength of a form of construction consisting of two skins of plywood, separated and stabilized by a core comprising strips of wood half-notched together to form a continuous grid, is examined theoretically and experimentally to determine its structural efficiency. A design procedure is included, and the test results show that reasonably high structural efficiencies were obtained.

Section 1 contains a general explanation of the work and descriptions of the specimens. The theory by which the work is attempted is presented in Section 2, and the detailed construction of the grid panels is described in Section 3. Sections 4 and 5 give the test procedure and the results of the series of tests. The panels were all efficient on a weight-strength basis, although the failing loads were not predicted accurately. It is stated that further work is necessary, however, before the ultimate loads can be predicted accurately. *Report ACA-16,* April, 1945.

British Air Registration Board

Amendments to Air Navigation Regulations. Certain changes have been made in the (British) Air Navigation Order and Air Navigation Regulations for 1946, and these changes are

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summarized in notices to licensed aircraft engineers and to owners of civil aircraft. Notice No. 2 deals with aircraft engineers' licenses. The new form of licenses is to replace the existing form. A list of the addresses of the Surveyors of the Board in Great Britain and overseas is included.

Notice No. 6 concerns changes in the British Civil Airworthiness Requirements with regard to the issuance and renewal of certificates of airworthiness; approval of prototypes, specifications, design and inspection organizations, radio-design organizations; and loading instructions. Other subjects include the weighing of aircraft; the granting, extension, and renewal of aircraft-engineer licenses; and maintenance, overhaul, modifications, and replacements of aircraft.

Notice No. 7 refers to cancellations of certain regulations formerly in effect. Notice No. 9 deals with the revised Certificate of Safety for Flight and for public-transport aircraft, showing that the aircraft have been maintained in accordance with maintenance schedules provided by the Board.

All of these new regulations are dated February 14 and were scheduled to become effective March 1, 1946.

British Information Services

Measurements of Pitching Moment Derivatives for an Aerofoil Oscillating about the Half-Chord Axis. J. B. Bratt and S. Scruton. The development of a technique is described in which a magnetostriction stress indicator is applied to the measurement of the instantaneous aerodynamic forces on an oscillating airfoil. A detailed description of the method in relation to the aerodynamic pitching moment on an airfoil performing pitching oscillations about a spanwise axis at the mid-chord position is presented. The paper includes the results of measurements made at aspect ratios of 2.7 and infinity, in which the effects of variation of frequency parameter, Reynolds Number, mean incidence, and amplitude of oscillation were investigated. The effect of disturbance to the flow was also examined. A comparison with theoretic values is made for those cases in which the pitching moment variation with time is sinusoidal, the results being expressed in the form of nondimensional derivative coefficients. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1921*, British Information Services, New York, $2.10.

Reports and Memoranda of the Aeronautical Research Committee Published Between 1st July, 1939, and 30th June, 1945. *R. & M. No. 1950* contains a list of the Reports and Memoranda published by the Aeronautical Research Committee, between July 1, 1939, and June 30, 1945. The reference numbers other than R. & M. are not consecutive, since many reports are confidential to the Committee and not for issue to the public.

Most of the memoranda will be published in the annual technical volumes. A few are published in special monographs. The corresponding references to Committee numbers have been inserted for the convenience of members of the Aeronautical Research Committee and its subcommittees. *R. & M. Nos. 1900* and *1913* have not yet been issued and are not included in this list.

Previous lists of the Committee's published papers are *R. & M. Nos. 650, 750, 1650, 1750*, and *1850*. Classified lists of reports on sale as separate issues, with prices, are available. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1950*, British Information Services, New York, $0.30.

Summary of Formulae and Notations Used in Two-Dimensional Derivative Theory. W. Richard Jones. In this summary the formulas and notations used by the following writers in their respective papers on derivative theory are compared with the corresponding formulas expressed in the suggested standard notation of this report: (1) Duncan and Collar, (2) Theodorsen, (3) Kuessner and Schwarz, (4) Dietze, (5) Frazer, (6) Jones, (7) Cicala, (8) Lyon, and (9) Kassner and Fingado. It is believed that the classification includes most of the alternative formulas used for expressing the aerodynamic forces acting on an oscillating airfoil and on an airfoil-aileron-tab combination. The basic assumptions made in the theory are stated in Section 2, and expressions for the air-load coefficients for a plain airfoil and an airfoil-aileron-tab with the aileron and tab hinged at their respective leading edges are revealed in Section 3. In Tables 1 (a), (b), and 2, the symbols used to represent certain functions and parameters that are involved in the formulas are listed for comparison with the notations used by other writers. The functions that are dependent on the aileron and tab hinge positions are defined in Appendix 1, and their numerical values as deduced from the results given by Kuessner and Schwarz are tabulated in Tables 6 and 7 (a), (b), (c). For convenience, the reference point is taken at mid-chord of the airfoil, but the formulas corresponding to any other reference point can be readily obtained by applying the transformation formulas of Section 4. Alternatively, the formulas of Section 3 and Section 4 can be expressed concisely in matrix notation as shown in Appendix 2. The values of the air-load coefficients for a plain airfoil are presented for a range of values of the frequency parameter in Table 5, and the actual formulas for the aerodynamic forces used by the writers already mentioned are given in Section 5. In Section 6, the vortex strip theory method of obtaining the appropriate three-dimensional air-load coefficients for a wing of finite span is briefly outlined.

The fundamental function, which is involved in the formulas for the air-load coefficients, is defined in Section 7, and its numerical values are cited in Table 3 for a large range of the given frequency parameter. Approximate representations of the lift vector as given by R. T. Jones, Sears, and Frazer are also included. Frazer's approximation is valid to within 3 per cent in the given range and is in a convenient form for the calculation of air-load coefficients for a tapered wing by vortex strip theory, provided the value of the frequency parameter corresponding to the tip chord is not less than 40 per cent.

In Section 8, the integrals of *R. & M. 1500* are expressed in terms of Hankel Functions, and the numerical values of one of these integrals are included in Table 4 for a large range of values of the parameter of that paper. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1958*, British Information Services, New York, $1.20.

Note on the Change of Characteristics Experienced by an Aerofoil in a Closed Tunnel of Rectangular Section. R. W. Piper. Information was required about the spanwise distribution of downwash along a rectangular wing of 8.5-ft. span in the Royal Aircraft Establishment 11-ft. tunnel. With the usual assumptions of the Prandtl airfoil theory, an exact mathematical solution for the characteristics, or lift distribution, of a rectangular wing in a rectangular closed tunnel has been obtained. The method is, however, quite general and is applicable to all types of tunnels. Results are tabulated for closed and open jet types of tunnels of rectangular, circular, and elliptic sections.

It is found that the difference between the lift distributions in free air and in the tunnel is negligibly small and that the mean tunnel correction factor, based on the assumption of elliptic distribution of lift, is sufficiently accurate even at such a high ratio of wing span to tunnel width. The calculations do not help to explain the higher values of maximum lift coefficient found in closed tunnels. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1962*, British Information Services, New York, $0.60.

Heat Transfer Calculation for Aerofoils. H. B. Squire. A method of calculation of the rate of heat transfer from the surface of an airfoil maintained at a temperature above that of the stream was required, including allowance for the effect of dissipation of energy in the boundary layer. A convenient method of calculation is developed for laminar boundary layers, and the best method of applying Reynold's analogy to the turbulent layer is discussed. The methods are applied to calculate the heat transfer from the NACA 2409 and 2415 airfoils at C_L = 0.24 and C_L = 0.8. Simple formulas for the rise in surface temperature caused by dissipation are derived. *Ministry of Aircraft Production, Aeronautical Research Committee, R. & M. No. 1986*, British Information Services. New York, $1.20.

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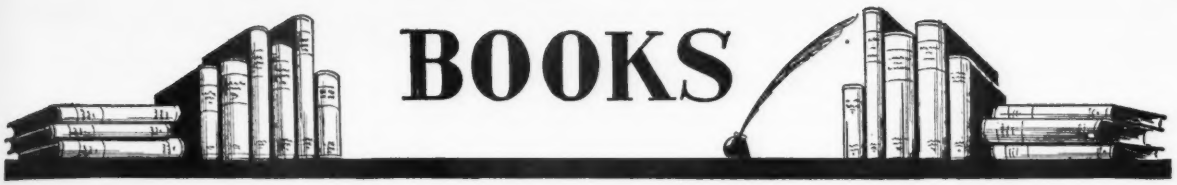


The Aircraft Annual, 1946

Edited by David C. Cooke

Contents: Airlines of the United States; Lightplane Flying; National Airport Plan; War in the Air; The U.S. Army Air Forces; The U.S. Navy Air Service; Strategic Bombing in Europe; What's New in the Air; Late Military Developments; Miscellaneous Activities; The Manufacturing Industry.

The 1946 edition of The Aircraft Annual has been considerably enlarged in order to set forth the advances that have been made since the revival of peacetime aviation. Latest developments in military aviation are described.

New chapters are devoted to light-plane flying, the national airport plan, and the air lines of the United States. With the aid of elaborate photographs, the book provides the reader with an understanding of the aviation question today and draws a picture of peacetime aviation programs that will be undertaken. Robert M. McBride & Company, New York, 1946; 304 pages, $3.00.

The Story of American Aviation

Jim Ray

Contents: The Beginnings of American Aviation; Aviation in America in Its Early Days; First Army Airplane; America Becomes Air-Minded; The Army and Navy Spread Their Wings; United States Military and Naval Aviation, World War I; The First Transatlantic Flight; Men and Machines, World War I; The First Air Mail; Precision Bombing Is Born; The U.S. Navy's First Aircraft Carrier; The First Flight Around the World; Air Progress; America's First All-Metal Transport; Better Power for America's Airplanes; Record-Making Fokker Tri-Motor Transport Plane; Air Transport Grows; Donald Douglas' Dream Comes True; Safety in Flight; Luxury Airliners and Skysleepers Make Air Travel an Accepted Fact; Pan American Clippers Conquer Pacific Skies; Pan American Clipper Inaugurates America's First Transatlantic Air Transport Service; Private Planes; Superchargers and Super-Airliners; Air Power for World War II; Naval Aviation, 1922–1935; Shipboard Fighters; Battleship of the Air; Naval Aviation Gets Ready; The U.S. Navy's First Long-Range Flying Boats; Technical Progress in the U.S. Army Air Corps in the Thirties; Army Attack Aviation and Training; Superfighter: Man-Made *Thunderbolts* Rip Wide a Path to Victory; Superfortress; Naval Aviation in the Early Months of World War II; The U.S. Navy's Deadliest Fighter Plane; Dive-Bomber; Our Flying Navy; Aerial Armada; Postwar Aviation; Index of Persons.

With the exception of aeronautical annuals and books published outside the United States, books reviewed in this section may be borrowed without charge from The Paul Kollsman Library of the Institute of the Aeronautical Sciences, 2 East 64th Street, New York 21, N. Y.

Illustrated by hundreds of sketches and water colors by the author, this condensed history of the development of flying in the United States will find many interested readers. There have been few books written about our aviation that describe the epoch-making era as clearly and with such details as Ray does in this short narrative.

The author does not confine his account to the dry facts of chronologic records but introduces some of the leading personalities in aviation and the airplanes they have designed. Gill Robb Wilson writes in the Foreword: "Mr. Ray has portrayed the engineering advancement which underlies the structure of our swiftly developing air age." The John C. Winston Company, Philadelphia, 1946; 104 pages, $2.50.

Wings of Tomorrow

Clive Turnbull

Contents: The Flying Sailor; The Struggle with the Strait; A New Deal in Aviation; The Line Grows Up; Wings over New Guinea; How It All Works; New Horizons; The History of the A.N.A. Fleet.

If this book had been titled "A History of Australian Civil Aviation," it would have prepared the reader for a well-told story of how air transport "down under" commenced and developed. Flying in the South Pacific has been centered in Australia, New Zealand, and New Guinea.

The connecting air routes between these countries have given opportunities for the emergence to world-wide fame of such pilots as Kingsford Smith, Hinkler, Parer, P. G. Taylor, Victor Holyman, and many other pioneers. From beginnings with small private planes there followed a gradual enlargement of the scope of the operations until the war.

In 12 years a great fleet of aircraft was ranging the continent. The Australian National Airways flies a network of air routes of 6,540 miles. The war has increased the possibilities of the use of air transport in the Pacific area of the Southern Hemisphere.

The title of the book is intended to indicate that Australia promises to play a prominent part in future international air lines. The F. H. Johnston Publishing Company, Sydney, Australia, 1945; 63 pages, 7*s.* 6*d.*

The Fundamentals of Aviation

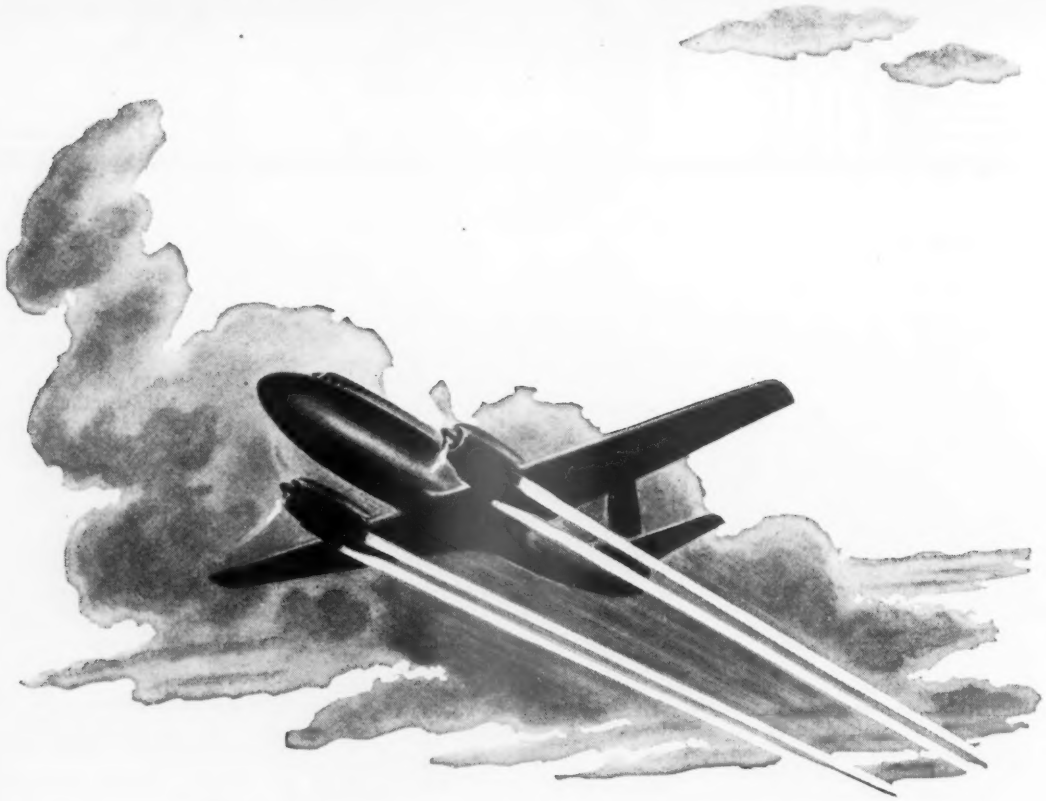
Henry Lionel Williams

Contents: How Men Learned to Fly; Flight by Gas Bag; The Mechanics of Flight; Flying Machines and Windmills; The Anatomy of the Airplane; Flying Horsepower; Props, Rotors, Rockets, and Jets; Mechanical Brains and Telltales; How Airplanes Are Flown; Effects of Flight on the Body; The Air and the Weather; Signposts of the Air; Flying on Schedule; Some Safety Rules.

The basic factors of air transportation are presented in language that can be easily understood by the student flier and others interested in aviation and its future. The operation and principles governing the flight of both lighter-than-air and heavier-than-air craft are explained.

Beginning with man's earliest attempts at the conquest of the air, the author traces the development of the airship, the airplane, and the helicopter to the present day; weighs the problems that still await solution; and explores the future possibilities of aviation.

The mechanics of flight, as well as the construction of the air frame, power plant, and accessories, is simply explained. The book gives the essence of what has been learned from two wars about airplane design, construction, and operation; navigation systems; and meteorology. It also supplies information about flight rules and safety measures governing commercial and private flying and gives some insight into airline operation and maintenance methods. The future of transoceanic air freight and travel is discussed. The Blakiston Company, Philadelphia, 1946; 282 pages, $1.00.



WORLD'S *First* TURBO-JET COMMERCIAL AIRLINER

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To its long record of achievement in aviation, The Glenn L. Martin Company now adds the world's first commercial aircraft powered with both gas turbine and jet propulsion. Being built for United Air Lines, this new plane is a cargo-carrying version of the Martin 3-0-3 airliner with its pressurized cabin for high-altitude flying. Use of the new General Electric TG-100 gas turbine-jet engines will give speeds approximating 400 m.p.h.—while the use of kerosene as a fuel, instead of high-octane gasoline, will materially reduce operating costs. When this plane enters service next year, coast-to-coast flying time, including two stops, will be cut to 8 hours. And after thorough testing as a cargo carrier, this plane will make its high speed and efficiency available to airline passengers.

In the words of a United Air Lines spokesman, this new Martin development represents, "The biggest step forward in aviation since the all-metal airplane." THE GLENN L. MARTIN COMPANY, BALTIMORE 3, MD.

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Experimental Stress Analysis

Edited by C. Lipson and W. M. Murray

Contents: "Strain Gage Technique," by L. M. Ball, Chrysler Corporation; "Use of Strain Gages on Wind Tunnel Models," by K. F. Sibila, Daniel Guggenheim Airship Institute; "Photoelasticity as a Designer's Tool," by R. E. Orton, Acme Steel Company; "A Study of Certain Mechanically-Induced Residual Stresses," by Donald G. Richards, Hamilton Standard Propellers Division of United Aircraft Corporation; "Precision Determination of Weight by Means of Bonded Strain Gages," by A. L. Thurston, Cox & Stevens Aircraft Corporation, and R. W. Cushman, The Foxboro Company; "The Application of Stress Models to Specific Structural Problems," by S. F. Tingley, Goodyear Aircraft Corporation; "The Use of a Plastic Model in Crankshaft Analysis," by D. M. Pearce and J. Modrovsky, Wright Aeronautical Corporation; "Stress Analysis of Shafting Exemplified by Saint-Venant's Torsion Problem," by Thomas James Higgins, Illinois Institute of Technology; "Dynamic Stress Analysis with Brittle Coatings," by Greer Ellis, Magnaflux Corporation, and F. B. Stern, Jr., Massachusetts Institute of Technology; "Experiences with Highly-Stressed Aircraft Engine Parts," by Forest R. McFarland, Packard Motor Car Company; "Repeated Load Tests—Some Experimental Investigations on Aircraft Components," by F. D. Jewett and S. A. Gordon, The Glenn L. Martin Company; "The Structural Analysis and Significance of Rivet Shear Tests," by George B. Holback, The Glenn L. Martin Company.

The first section of Volume III of the Proceedings of the Society of Experimental Stress Analysis contains a group of technical articles by members of the association, dealing with typical problems within the field of the Society's work. While some of the articles are of a general nature, applicable to numerous industries, several of the studies have particular reference to stress-analysis work in aircraft engineering. The articles are extensively illustrated, and the text matter is further clarified by numerous graphs, charts, and tables.

In addition to the technical papers, the book contains a list of individual and corporate members of the Society for Experimental Stress Analysis. The concluding pages of the book list the contents of earlier volumes. Addison-Wesley Press, Inc., Cambridge, Mass., 1945; 154 pages, $5.00.

Elementary Mechanics of Fluids

Hunter Rouse

Contents: Introduction to the Study of Fluid Motion; Fluid Velocity and Acceleration; Pressure Variation in Accelerated Flow; Effects of Gravity on Fluid Motion; One-Dimensional Method of Flow Analysis; Effects of Viscosity on Fluid Motion; Surface Resistance; Form Resistance; Lift and Propulsion; Surface Tension; The Role of Compressibility in Fluid Motion.

The book is based on the experience of the author and members of the mechanics staff of the University of Iowa in teaching fluid mechanics. The fundamentals of fluid mechanics are thoroughly covered, and many new phases of the subject are discussed. The author explains the development of flow principles from the basic equations of mechanics and carries each principle through to its useful application. Over 400 original problems of a practical nature are included in the text. John Wiley & Sons, Inc., New York, 1946; 376 pages, $4.00.

Simplified Punch and Diemaking

James Walker and Carl C. Taylor

Contents: Introduction; Plain Round Blanking Die; Typical Blanking Die; Heavy-Duty Dies; Sectional Blanking Dies; Compound Blank and Pierce Dies; Kirksite Blanking Dies; Progressive Dies; Piercing and Trimming Dies; Bending and Forming Dies; Drawing Dies; A Manufacturing Problem and Its Solution; Machine Supplement; Summary.

A book is offered for those requiring knowledge concerning the construction and operation of punches and dies. Both authors are tool engineers connected with a large aircraft manufacturer. To simplify the problem of imparting information concerning the making of punches and dies, a novel approach to the subject is used.

The first chapter is an introduction to the broad field of diemaking and contains sufficient general information to prepare the beginner for the diemaking instruction given later. Successive chapters deal with dies of increasing complexity until all commonly used types have been explained.

It has been the aim of the authors to avoid obsolete processes, designs, and methods and to confine themselves exclusively to the design, use, and adaptation of the many sets of tools illustrated. The Macmillan Company, New York, 1946; 235 pages, $5.00.

Book Notes

The Engineer in Society, by John Mills; D. Van Nostrand Company, Inc., New York, 1946; 196 pages, $2.50.

A survey of the problems that face the engineer and scientist in a society catering to the business man and financier and to the politician and statesman. The author expresses his views on the importance and quality of aptitude tests, the salaries of engineers and scientists, woman's part in engineering work, business executives and research, and the overall organization of scientists and engineers.

The Ships and Aircraft of the United States Fleet, by James C. Fahey; Ships and Aircraft, New York, 1945; 96 pages, $1.00.

The Victory Edition of *The Ships and Aircraft of the United States Fleet* is the first revision of that comprehensive survey since the ending of the war. Considerable information that was withheld for reasons of security has been released since the surrender of Germany and Japan, and the Navy's shipbuilding and aircraft-procurement programs of the war years can now be detailed. A complete roster of combatant vessels and fleet auxiliaries to which names and serial numbers were assigned is arranged according to class or type. Various classes of naval aircraft are described.

Standard naval nomenclature is used throughout the book. In addition to their type symbols, each vessel or aircraft on the Navy list has an individual serial number. Many ships have been reclassified, and these changes up to September 1, 1945, are indicated in the text.

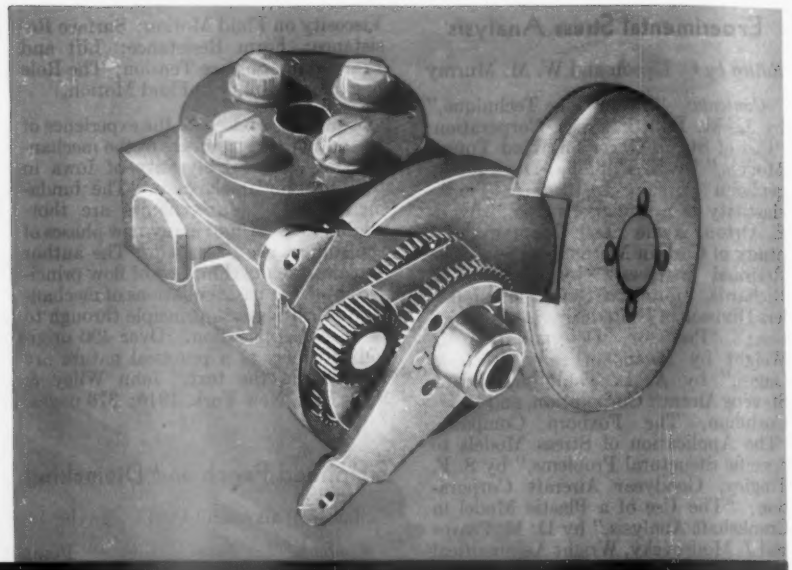
The statistical information is presented in the usual form of tabulations, with pictures of typical units of each class of surface ship and aircraft, supplemented by brief comments in the text.

The aircraft section contains complete lists of naval aircraft, divided into categories according to the type and purpose of the aircraft described. The construction, equipment, and characteristics of each type of aircraft are outlined briefly, accompanied by illustrations. The section includes land-based airplanes, carrier-based airplanes, seaplanes, and lighter-than-air ships.

The Pacific Islands Handbook, 1944; by R. W. Robson; The Macmillan Company, New York, 1945; 371 pages, $4.00.

The first American edition of an Australian annual reference book on the Pacific Islands. It corresponds to the 1944 edition of the Australian publication but has been extensively rewritten and revised to bring the geographic and historical data up to date. The order of the material has been rearranged, placing the islands of the Pacific in five sections—Polynesian, Micronesian, Melanesian, Indonesian, and Non-Tropical. To cover the war phases of the history of the islands, there has been included a chronology of the Pacific war from the attack on Pearl Harbor to the date of publication, and a note is added as an introduction to each territory briefly describing how that territory has been affected. The book is of aeronautical interest because it gives particulars about a vast area in which extensive military aviation activities were carried out during the war.

precise control



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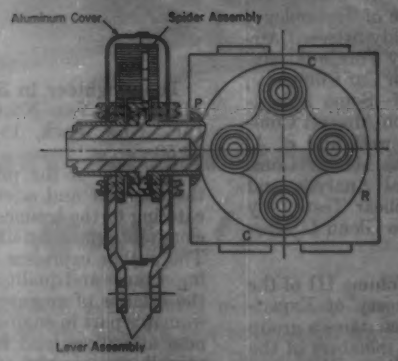

Two planetary gears are mounted on a spider fixed to the valve operating shaft. These gears are in mesh, and each meshes with a sector gear, free to rotate on the shaft. One sector gear is connected to the control lever; the other to the mechanism being controlled. Clockwise movement of the control sector causes opposite rotation of the planetary pinion in mesh with the second planetary gear, resulting in a counter-clockwise movement of the spider. This rotation opens the four-way valve permitting fluid flow to motor or cylinder. Since the unit being controlled is mechanically connected to the second sector gear, which also meshes with the planetary gear on the spider, movement of the controlled element tends to rotate the spider clockwise so that the valve is returned to neutral, thus locking the controlled element in the pre-determined position.

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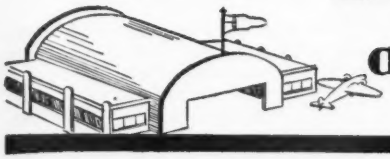

Aircraft-Equipment Testing Procedure

General Outline for Aircraft Equipment Testing. An outline of aircraft-equipment testing as developed by the aircraft-manufacturing industry is intended to facilitate the incorporation of new or revised equipment in aircraft by providing for the uniform testing of such equipment by the equipment manufacturer.

This outline, developed by a special panel of the Aircraft War Production Council, is primarily a statement of technical policy and is not in itself mandatory. It is made so only when referred to or incorporated in procurement specifications. One primary use is as a reference and guide for aircraft designers in preparing specifications for equipment of special design to meet a particular need. Similarly, the outline is of value to equipment manufacturers in developing equipment for general use. It is a source of technical information in the planning of tests to meet various operating requirements that should be of help to independent testing laboratories. It should be a helpful factor in obtaining uniformity of test results regardless of the laboratory in which the tests are conducted.

Part I outlines the testing policy. Part II gives the requirements of the test report; Part III, availability of drawings; and Part IV, information about general environmental conditions to which equipment in aircraft is subjected. Part IV also outlines, for each of these conditions, the method of test and performance items to be determined.

The appendixes give the environmental conditions peculiar to specific classes of equipment. They refer to electrical, radio, and instrument equipment; hydraulic, fuel, and oil-system equipment; mechanical equipment; and heat-exchange equipment. *National Aircraft Standards Committee, Aircraft Industries Association of America, Inc.*

Aerial Pickup Methods

Air Pick-Up. The story of the development of aerial pickup methods for mail, express, and freight shipments is told in an illustrated booklet of 21 pages. It reviews the history of All American Aviation, Inc., the company's contributions in commercial service to the public, and its military service to the nation. An estimate of its future is presented, with emphasis on the accomplishments of the late Richard C. du Pont, the founder of the company. In addition to a description of the operation of the pickup system, charts show the growth of the volume of such shipments compared with the figures for all types of air cargo. One section gives details about the company's manufacturing facilities, and another contains a forecast of developments to come in air pickup. *All American Aviation, Inc.*

Industrial Products

Products of Eaton is a small booklet containing brief descriptions of the principal peacetime industrial products of Eaton Manufacturing Company and the new products developed in its research laboratories for future industrial markets. Among the devices applicable to the aeronautical industries are engine valves, valve lifters and tappets, valve-seat inserts, rotary pumps, coil springs, castings, cold-drawn steel, stampings, lock washers, electromagnetic clutches, power screws, and others. *Eaton Manufacturing Company*, Cleveland.

Air-Travel Comforts

Luxury Air Travel. The January, 1946, issue of the *Handley Page Bulletin* contains a description of the comfort features of the Hermes commercial airplane. In addition to the details of the passenger accommodations provided in that airplane, specifications and performance data are tabulated. The information is printed in parallel columns in English, French, and Spanish. *Handley Page Bulletin*, January, 1946.

Mock-Up of Airplane Interior Serves as Showroom

Sky Luxury Show Room. E. Gilbert Mason. Photographs of the full-scale interior mock-ups of the DC-6 depict what the accommodations and conveniences in the new plane will be. It is also explained that the mock-up serves as a showroom in helping to sell the aircraft. *Douglas Airview*, January, 1946.

Continuous Cast Bronzes

Continuous Cast Bronze Rod and Tubing, Bulletin 69. The bulletin describes the process of producing Ampcoloy Continuous Cast Bronzes. It contains tables of alloys and sizes available, physical properties, microphotographs of leaded bronzes, typical specifications, and a table of rod weights, together with conversion factors for other alloys. This material in rod and tube form is produced by the American Smelting and Refining Company and sold by Ampco Metal, Inc. Among the cited benefits to users of continuous cast bronzes are improved quality of products, faster production, and lower production costs. The bulletin points out that for maintenance uses certain benefits accrue, such as no waste, stock readily available, less frequent replacements, and no porosity of material. Other claims are that practically no scrap accumulates because of metal faults and no preliminary machining operations are needed because of the excellent surface finish of the rod. *Ampco Metal, Inc.*, Milwaukee.

New Type "AP" Bulletin

Cannon Plugs for Radio and Telephone Circuits. The first revised edition of the Electric Type "AP" Bulletin has appeared. This 12-page catalog lists five plugs and three receptacle types, which, with the six insert arrangements, make possible 48 different fittings. The series was originally designed for the U.S. Army Signal Corps but has also been used in many types of radio, telephone, and sound-equipment circuits where a rugged fitting, gasketed for weather resistance, is required.

Besides an extensive data section, there are exploded views of three plugs and one receptacle, dimensional sketches, photographs, and application views. Dust caps are also illustrated. *Cannon Electric Development Company*, Los Angeles.

Rotameters

Bulletin 45-A describes the styles, features, and applications of rotameters. Included are details of the Master Enclosed Rotameter for normal pressures and temperatures; the Armored Rotameter for high pressures and temperatures; meters for recording, controlling, and totalizing rates of flow; meters for extremely low and extremely large flow rates; Laboratory Rotameters, and others. This illustrated bulletin also contains two pages of engineering recommendations for the types of rotameters and materials of construction to be used in measuring the flow rates of many difficult and corrosive fluids and gases. There is a discussion of the company's Bead-Guide Tube, which is credited with eliminating the use of float guide rods and other float-stabilizing means. In addition, a rotameter capacity guide is appended. *Fischer & Porter Company*, Hatboro, Pa.

Instruments for Mapping and Surveying

Precision Photogrammetric Equipment. Together with information about the facilities offered by the company, descriptive data about a line of precision photogrammetric equipment are contained in this illustrated pamphlet. The instruments depicted and noted include an explorer contour finder, an explorer height finder, a pocket stereoscope, contact printers, topographic mapping cameras for vertical and oblique photography, intervalometers, process control timers, vertical and oblique sketchmasters, compasses, camera mounts, recording cameras, etc. *Abrams Instrument Corporation*, Lansing, Mich.

Design Features and Advantages of Controllable-Pitch Propeller

Controllable Pitch "Prop" Announced. Included with an announcement that Continental Motors will manufacture controllable-pitch propellers are data concerning the design features of the planned propellers, the sizes that will be manufactured, and the advantages imparted to an airplane by this type of propeller. Design features of the new propellers are summarized as follows: (1) stationary hydraulic actuator; (2) no packing glands of any kinds; (3) closed hydraulic system; (4) simple, foolproof, push-pull control; (5) standard bearings for blade-hub combination; (6) blade bearings independent of blade ferrule, making possible bearing replacement without need to change blade or ferrule; (7) positive hydraulic force to increase or decrease blade pitch obtained by a double-acting hydraulic unit; (8) fixed stops with auxiliary adjustment for operation from airports at different altitudes; (9) constant-speed operation obtainable by simple addition of a governor; and (10) a wide blade angle range available to cover a large range of performance. *The Red Seal*, February, 1946.

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Springs for Instruments

Instrument Springs. The second edition of a booklet on instrument springs discusses more fully the grade of spring needed for the satisfactory performance of instruments. The study takes into its scope comprehensive explanations of spring rate, how the desired rate of loading in a spring is obtained, hysteresis, creep, and thermally self-compensating springs. In addition, it describes the design and manufacture of instrument springs, giving spring formulas.

A large part of the content of this booklet appeared originally in a magazine called *Wire & Wire Products.* It is stated that at the time of the pamphlet's publication it was still deemed advisable to omit many of the details of the application of self-compensating springs to aircraft instruments. *All-Weather Springs*, New York.

Screw-Threaded Devices

Stronghold Screw Products. Net Price Catalog No. 15 includes descriptions, illustrations, tables of data, and price information pertinent to a line of screw products. The engineering data and technical information presented cover dimensions, standards, specifications, and weights of the devices. Net prices are shown for each item, with current market discounts already deducted.

The loose-leaf catalog is separated into twelve indexed sections. The first refers to aviation products; the second, to machine screws; the third, to the Hex-Scru; and the fourth, to cap screws. Sections five deals with set screws; six, with wood screws; seven, with sheet metal screws; and eight, with bolts, studs, and rods. The ninth section is concerned with nuts; the tenth, with washers; the eleventh, with rivets, eyelets, and lugs; and the twelfth, with pins. *Manufacturers Screw Products*, Chicago.

More Liberal Insurance Policies Indicate Greater Safety of Air Travel

Insurance Paces Air Safety. Holgar J. Johnson. The trend of liberalization in aviation underwriting by the life insurance companies is regarded as an indication of the progress that has been made in developing the safety of air transport. The policy of gradual liberalization and the reasons for it are reviewed briefly, and a C.A.A. tabulation is included showing the steady decline in death rates in civil accidents during the past 15 years. *The Pegasus*, March, 1946.

Nylon Molding Powders

Five Molding Powders Now in Commercial Production. Recent extensions of the use of nylon molding powders for industrial products are outlined briefly. The material is used as a composition for injection molding, by which process numerous industrial products are now being manufactured. One such use to which attention is directed is a group of 14 molded nylon parts used in the Fairchild rate gyro. *Du Pont Plastics Bulletin*, Vol. 10, 1946.

Electric Connector for Low-Level Sound

Connector-Catalog Sheets. In a 4-page leaflet the new type "XL" microphone connector is described. It is explained that this unit was developed to meet the requests of radio and electronic manufacturers and broadcasting engineers for a small multicontact electric connector—plug and receptacle—that would ultimately become a basis for standardization for low-level sound uses by the industry.

Combining the features of other connectors originated by the same company, the Type "XL" has the following characteristics: small "midget" size, $2^{3}/_{32}$ overall length with a maximum diameter of $^{5}/_{8}$ in.; lightweight, two-plug types weighing 0.0792 and 0.0992 lbs., respectively; latch-lock device similar to Type "P"; polarizing means similar to Type "AN" and "K" aircraft connectors; removable inserts with tapped metal armor for insert-retaining screw; cable relief spring or removable cable clamp; contact No. 1 engaged before Nos. 2 and 3 to be used for ground circuits, if desired; rugged die-cast zinc shell with cadmium-plate finish (bright nickel when available); three 15-amp. silver-plate brass contacts in phenolic insert to accommodate No. 14 B&S stranded wire, and ample voltages for sound-equipment applications. *Cannon Electric Development Company*, Los Angeles.

A Year's Progress

1945 in Review. With remarks concerning the indication they give of future trends, developments achieved by Eastern Air Lines during 1945 are recorded. The review takes into account route expansions, equipment analysis, changes in the fare structure, and personnel expansion. *The Great Silver Fleet News*, January-February, 1946.

Retail Catalog of Aircraft Accessories

Firestone Aircraft Accessories. A retail catalog for private-plane owners serves as an information booklet about a line of aircraft accessories. It may also be used by dealers as a direct-mail piece of advertising.

The catalog describes, and gives the prices of, such items as aircraft tires,

tubes, wheels, brakes, brake lining, aircraft "dopes" and finishes, tools, instruments, clothing, and other accessories. It will be revised frequently to keep up to date with the complete line of merchandise. *The Firestone Tire & Rubber Company.*

Measuring Instruments

Standard Gages. Descriptive material, price information, and illustrations are contained in this 180-page catalog relative to various types of gages. Supplemented by conversion tables and an index, the major portion of the book is divided into five sections. The first one deals with indicating gages, including dial bore, dial snap, dial plug, dial pin, and dial depth types. Dial indicators are described in the second section; comparators, in the third. Section number four discusses adjustable limit gages, including snap, length, and pin models. The fifth and final section is devoted to a review of fixed limit gages and takes into its scope DuBo and TeBo gages, plug gages, ring gages, master discs, Gagematic discs, keyway gages, taper gages, and spindle-nose gages. *Standard Gage Company, Inc.*, Poughkeepsie, N.Y.

Bulletin of Stainless-Steel Fabricating

A Quarter Century of Stainless Fabrication and Engineering. A new edition of a file-folder bulletin on stainless-steel fabricating contains illustrations of the various types of recent stainless work for various industries. In addition, there is a table of standard type numbers and analyses. *Alloy Manufacturing Company, Inc.*, Pittsburgh.

Propeller Improvements

Shift from War to Peace. A survey of specific design and engineering advances that will be incorporated into Hamilton Standard propellers now being produced for peacetime aircraft. The developments include an inverse cam for various models of the Hydromatic propeller; adaptation to the Hydromatic of Super-Hydromatic reversing features; new hollow-steel blades; a blade-vibration absorber; and a new version of the four-engined synchronizer, also available in a two-engined version. Features of two small versions of the Hydromatic propeller are discussed. *The Bee-Hive*, January, 1946.

Cold Forged Nails, Rivets, and Screws

Cold-Forged Parts Can Improve Your Product and Cut Your Costs. The Uses and merits of cold-forged parts in the assembly of a product are noted, together with data about an extensive line of such parts. Among the advantages claimed for cold forgings as a basic operation in the manufacture of nails, rivets, threaded units, etc., are: (1) The wire from which they are made costs less than the bar stock used for screw-machine products; (2) there is little or no waste in the form of metal shavings; (3) higher speed production; and (4) greater strength. *John Hassall, Inc.*, Brooklyn.

Photograph Courtesy Thompson Products, Inc.

The heart of a jet propulsion engine, consisting of the turbine wheel and the nozzle diaphragm. The blades of the precision turbine wheel must withstand a centrifugal "tearing apart" pull of approximately 30,000 lbs. per sq.in. while red hot, although the tips of the blades are hardly thicker than heavy wrapping paper.

Jet Propulsion Principles

Jet Propulsion. How modern metallurgy and engineering have made practical use of jet propulsion principles that have been known since 130 B.C. is explained in a new booklet. The advantages of both jet and reciprocating type engines are enumerated, and the booklet describes in nontechnical language how a jet engine operates and some of the steps science is taking to improve this new source of power. *Thompson Products, Inc.*

Emergency Flame-Cutting Outfit

Emergency Cutting. Designed for fire-fighting and rescue squads, a pack-type emergency cutting outfit is described. The oxygen and acetylene cylinders, regulators, hand-cutting torches, etc., are supplied with such accessories as goggles, spark lighters, gloves, canvas bags, and replacement cylinder units that are housed in aluminum cases. All of these are carried in an adjustable canvas bag and the harness is strapped to the rescuer's back. Regulators are so positioned that they do not protrude and are preset for suitable oxygen and acetylene pressures. *Victor Equipment Company*, San Francisco.

Steam-Detergent Cleaning

How Oakite Steam-Detergent Cleaning Can Help You. Of interest to aviation maintenance cleaning men responsible for airport maintenance cleaning are savings in time, money, and effort being effected by steam-detergent cleaning methods. A recently published booklet describes applications of steam-detergent cleaning to (1) cleaning machinery equipment and parts for subsequent repair and overhaul; (2) preparing equipment surfaces for repainting or refinishing; (3) cleaning equipment that is too large for tank immersion or where suitable tanks are not available; and (4) paint-stripping. Emphasis is placed on steam-detergent cleaning as a simple, fast method for safely removing grease, oil, dirt, sand, and other deposits from all types of equipment through the combination of mechanical force, controlled heat, and effective detergent action of recommended materials. Savings of nearly 50 per cent of former costs and over 75 per cent of time and effort are reported on some cleaning operations using this method. *Oakite Products, Inc.*, New York.

Aluminum-Coated Steel

Armco Aluminized Steel. A 24-page booklet deals with special-purpose sheet steels for resistance to heat and corrosion. Aluminum-coated on both sides, this aluminized steel is said to resist destructive heat scaling up to 1,500°F. It maintains a bright shiny appearance after prolonged heating up to 900°F. and has good atmospheric corrosion resistance and good radiant heat reflectivity. In addition, this new sheet reportedly possesses the strength of steel at moderately elevated temperatures and has a lower coefficient of expansion than some of the nonferrous metals.

The booklet is illustrated by charts, photographs, and tables. It contains sections on heat reflectivity, mechanical properties, forming properties, painting and finishing, electrical conductivity, welding, brazing, and soldering. *The American Rolling Mill Company*, Middletown, Ohio.

Doman-Frasier Helicopters

Revealing that a new firm has been formed to develop and manufacture helicopters, a booklet depicts the first two models the company intends to produce. One is a proposed ten-place commercial helicopter; the other is called the LZI-Demonstrator. Both are designed for passenger and cargo-carrying use by suburban shuttle air lines. The backgrounds, engineering experience, and qualifying abilities of the men who will constitute the firm are summarized in the booklet. *Doman-Frasier Helicopters, Inc.*, New York.

Exchanging an Old Light-Plane Engine for a New One

Aircraft Engine Exchange Program. A new plan for exchanging used aircraft engines for remanufactured units. For certain fixed rates, reported in the article, a used Continental aircraft engine can be exchanged under this plan for a factory remanufactured product with which a new-engine guarantee is given. The replacement units are obtainable from local distributors or service stations. Accessory exchanges may be similarly made on a flat rate basis. *The Red Seal*, February, 1946.

Executives of Light-Plane Manufacturers

Radio Sketchbook of Personal Aviation. Portraits and "thumbnail" biographies of executives of America's light-plane

The new Honeywell blind approach Autopilot will bring planes in automatically regardless of weather conditions. This new electronic Autopilot, developed primarily for the commercial airline market, is based on experience gained in designing and building more than 35,000 Automatic Pilots for the Army Air Forces.

In addition to blind approach with the existing airport ground equipment, the new Autopilot provides increased simplicity of operation, a ride control which reduces discomforts of rough air, and automatic synchronization of the Autopilot with the airplane's attitude, which eliminates the necessity of "trimming" the Autopilot before engaging.

The new Honeywell Autopilot, weighing less than 60 pounds, is offered as a basic system to which blind approach equipment and other accessories can be added at any time, all designed to produce increased safety and augment the pilot's capabilities. Minneapolis-Honeywell Regulator Company, Aeronautical Division, 2670 Fourth Avenue South, Minneapolis 8, Minnesota.

CREATIVE ENGINEERING

Makers of the famous M-H Electronic Autopilot, used on AAF four-engined bombers

MINNEAPOLIS Honeywell CONTROL SYSTEMS

manufacturing companies comprise the central theme of a new brochure. With these are presented sketches of the aircraft the companies are building and some ideas on how radio contributes to the functional value and enjoyment of personal flying. The men pictured are the presidents of Aeronca Aircraft Corporation, Beech Aircraft Corporation, Globe Aircraft Corporation, Grumman Aircraft Engineering Corporation, Kellett Aircraft Corporation, Luscombe Airplane Corporation, Piper Aircraft Corporation, Republic Aviation Corporation, and Taylorcraft Aviation Division of Detroit Air-Craft Products, Inc.; the vice-presidents of Culver Aircraft Corporation, Engineering & Research Corporation, Fairchild Aircraft Division of Fairchild Engine & Airplane Corporation, Spartan Aircraft Company, and Waco Aircraft Company; and the sales manager of Stinson Division of Consolidated Vultee Aircraft Corporation. *Bendix Radio Division, Bendix Aviation Corporation.*

Generating Equipment

The New Products of Motor Generator Corporation. In brochure form, a preview has been released of products that are being offered for postwar sales. It includes new equipment developed during the war years, 1941 to 1945. Units shown include high-voltage motor-generator sets; generators for aircraft batteries; battery-charging electrical testing machines; waste-recovery metal-plating units; metal-coloring and finishing machines; materials-handling equipment; electroplating and electrodeposition sets; postwar railway equipment; special battery chargers; electric power units; buffers and grinders; magnet service generators; and automotive battery chargers. *Motor Generator Corporation, Division of Hobart Brothers Company*, Troy, Ohio.

Special Machine Tool

Catalog No. 45 contains constructional and operational details for a line of crank shapers. Illustrations are included and specifications are given for 12-, 16-, 20-, 25-, 28-, and 38-in. types. *The Smith & Mills Company*, Cincinnati, Ohio.

Skyhooks

Where Does Hy-Ten-Sl Bronze Fit into This Picture? Functions, design, and operation of "Skyhooks" are explained briefly in a 4-page broadside. Photographs and diagrams help to interpret how this equipment is used in the aerial pickup of cargo and mail. *American Manganese Bronze Company*, Philadelphia.

Proposal for Unification

Unification of the Armed Forces. The President's plan for unification of the U.S. Armed Forces is outlined in a 12-page pamphlet. Five fundamentals form the basis of the plan: (1) a single Department of National Defense, with a civilian Secretary at its head, assisted by a civilian Under-Secretary and Assistant Secretaries; (2) coequal status for Army, Navy, and Air, each under an Assistant Secretary, with the Navy retaining the Marine Corps and carrier, ship, and water-based aviation; (3) central supply and service organizations wherever necessary to unify military procurement; (4) a Chief of Staff of the Department and a commander for each of the three component branches—Army, Navy, and Air; (5) the Chief of Staff and three commanders would comprise an advisory body to the President and Secretary to help work out coordinated plans. In addition to President Truman's statement, the views of Secretary of War Patterson and of generals Marshall, Arnold, Eisenhower, and MacArthur are quoted. A plan chart demonstrates the status of the Air Forces and other armed services in the proposed arrangement.

Pro and con arguments concerning the proposed unification of the Armed Forces are set forth in a separate 8-page pamphlet. Objections to the unification proposals are given first, followed by the answers of the proponents of legislation pending in Congress. *The Air Power League*, New York.

Microwave Equipment

Klystrons and Accessories and Microline Instruments. A loose-leaf folder contains three separate publications on microwave equipment. The first, including illustrations, descriptions, catalog numbers, and reference charts, is an index to a group of Klystrons and accessories now available for varied applications. Constituting a brief study of microwave measurements, the second booklet discusses the problems of microwaves; power measurements; frequency measurements; impedance measurements; variable attenuators; impedance transformers; signal sources; signal detectors; fittings, connectors, and terminations; and typical microwave experiments. The third leaflet is composed of a group of data sheets relative to a number of microline instruments. These instruments include specific signal sources, frequency meters, wattmeters, attenuators, impedance meters, transformers, accessories, and fittings. *Sperry Gyroscope Company, Inc.*

Hose Fittings

Catalog Section 3100. A new catalog section on a line of hose fittings includes couplings, joints, clamps, washers, nozzles, nipples, and flanges. Instructions for properly attaching couplings and other types of fittings that add to service life and make the hose safer are featured. *The B. F. Goodrich Company.*

Torque Wrenches

JO Line Torque Tools. Tables of suggested torque values supplement a descriptive catalog of torque wrenches. The tools noted and illustrated are designed for aircraft applications, among others. There are special tools for production, maintenance, and inspection purposes. An explanation of torque is included in the catalog. *JO Manufacturing Company*, South Gate, Calif.

The Nature and Use of Stainless Steels

Handbook on Stainless Steel. Beginning with an explanation of the nature of stainless and heat-resisting steels, their types, and their properties, this manual lists their corrosion-resistance properties in various media. It then discusses the forms, sizes, and finishes of various stainless-steel products and the fabrication methods used for them. Tables and reference material offer a guide to the proper selection and correct use of the steels. *Allegheny Ludlum Steel Corporation*, Brackenridge, Pa.

Standardization in the Aircraft Industry

A Challenge Met. The work of the Society of Automotive Engineers in the standardization program of the aircraft industry is recounted. This booklet tells how the S.A.E. helped to standardize aircraft parts and the results of standardization upon engines, propellers, accessories and equipment, and materials. An organization chart indicates how the Society is set up, and photographs are shown of men who were leaders in aeronautical standardization. The booklet also explains what standardization is, charts the Government standards and specifications reviewed from 1941 to the present, and by means of other graphs traces the record of the acceptance of standardization work by the aeronautical industry since 1940. Names of the men forming the S.A.E. standardization committees are listed. In addition, there are appendixes covering Government standards and specifications reviewed and coordinated recommendations transmitted to the Government; S.A.E. aeronautical material specifications issued; S.A.E. aeronautical standards (AS) and aeronautical recommended practices (ARP) issued; and S.A.E. aeronautical information reports and other publications used. *Society of Automotive Engineers.*

Casting Procedures and Products

Haynes Precision Castings. A catalog on a line of precision castings demonstrates the characteristics and advantages of these castings. The type of materials used and specification ranges are noted, and a group of examples illustrates the design and structural features that can be obtained by means of the casting process. Typical parts that can be advantageously cast are listed, and precision-casting procedures are outlined briefly. Separate data sheets give the manufacturer's recommendations for the proper grade of material to use under the corrosive influence of a list of substances ranging from acetic acid to zinc sulphate. *Haynes Stellite Company, Unit of Union Carbide and Carbon Corporation.*

(*Continued on page 113*)

*Magic Touches in "The Modern Magic Carpet"**

STABILITY . . . CONTROL . . . SIMPLICITY

Stability of the Bell Helicopter

Pipe Line Inspection

HELICOPTERS have many unusual features. They take off and land vertically . . . fly forward, backward or sideways . . . hover in mid-air . . . do many practical jobs no other form of transportation can touch. All of these achievements are unique, but there is something *especially* different about the Bell Helicopter—it has a new kind of built-in stability—*one of the most important developments in helicopter design.*

Mounted under the rotor is a "stabilizing bar"—a bar that rotates steadily in a horizontal plane like a gyroscope. This stabilizing bar is linked to the helicopter control system—*ingeniously* linked so it constantly corrects any tendency of the helicopter to tilt, pitch or sway. This automatic action by the stabilizing bar makes the Bell Helicopter easier to fly . . . easier to learn to fly . . . even safer to fly. It introduces . . . for the first time . . . built-in stability in a helicopter.

The stabilizing bar . . . simple . . . reliable . . . essential . . . is another in the long list of exclusive Bell developments—the kind of developments you can expect from Bell Aircraft—the "Pacemaker of Aviation Progress."

* * *

Famous "Firsts" by **BELL**

- *First* cannon-carrying fighter plane—the AIRACOBRA.
- *First* American jet propelled plane—the AIRACOMET.
- *First* helicopter with automatic, built-in stability.

**Reg. applied for U.S. and principal foreign countries.*

BELL *Aircraft* **CORPORATION**

P. O. Box 1, Buffalo 5, New York

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PACEMAKER OF AVIATION PROGRESS

From the Industry

Industrial Pressure or Vacuum Switches

Three new, 8-oz. switches have been developed for the control of liquids or gases for either pressure or vacuum up to 200 lbs. Typical applications are in the control of compressors and pumps.

The switches are rated at 10 amp., 110-volts a.c. Type M-500 has an externally adjustable range with a fixed differential, Type M-600 can be reset manually from the outside, and Type M-700 has an adjustable differential. Contact arrangement in the first two can be specified as normally closed, normally open, or double throw. The third design is available only with normally open contacts. Pressure connection is by means of a $^1/_8$-in. pipe nipple. Aerotec Company, White Plains, N.Y.

Hydraulic System for Remote Control of Equipment

A development for the remote control of hydraulic equipment is called the "Hydro-Switch System." The arrangement is composed of either a small panel- or pedestal-mounted switch and a new-type valve located near the equipment to be moved, or the switch with valve is located integrally in the actuating cylinder. Weight for the entire system is stated to be less than that of a conventional system, and engineers estimate that installation costs are 50 per cent less than for older units.

The new device is different in that it does not depend on pressure for operation but utilizes hydraulic flow to provide an all-hydraulic system. Only two lines, with a small drain line connected to the nearest hydraulic return, provide fourway operation. While lines between switch and valve of the Hydro-Switch System can be of any size, it is not necessary for them to be larger or heavier than $^1/_8$ in., because the rate of flow being utilized as the motivating force is low.

An additional feature is that it introduces the use of an actuating cylinder head to house the valve. This is possible because of the simplified control and the reduced sizes needed with the fourway control.

The Hydro-Switch System provides for accurate control of the device being operated and does not prevent sequence operation of equipment. The system is not limited to any particular operating pressure. It can be used in any of the three standard aircraft systems of 1,000, 1,500, or 3,000 lbs. per sq.in. pressure, as well as at higher or lower ranges. Air Associates, Inc., Teterboro, N.J.

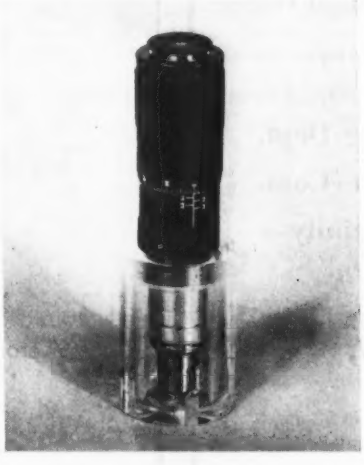
Releases are printed as received from companies and other aeronautical organizations and the responsibility for the accuracy of all statements is therefore not assumed by the Aeronautical Engineering Review.

Air-Express Records in 1945

Domestic air-express shipments in 1945 reached a total number of 2,165,132, a rise of 22.06 per cent over 1944, which also had broken all previous records with 1,773,823 shipments. Gross revenue exceeded the mark set in 1944 by 19.2 per cent, amounting to $13,645,806 for 1945 as compared with $11,447,715 for the year before.

Air-express traffic—consisting mainly of war-essential machine parts, drugs, and printed matter in the earlier part of the year and reconversion machinery, household appliances, and store merchandise in the latter part—weighed about 40,745,100 lbs. as compared with 34,276,834 lbs. in 1944.

International air express totaled 324,461 shipments, marking a 30.5 per cent rise over the 248,541 recorded in 1944. Charges paid by shippers during the year on the international traffic came to $1,499,947, constituting a 41.2 per cent gain over 1944. Air Express Division of Railway Express Agency, Inc.



Aireon Manufacturing Corporation's optical micrometer.

All-Position Mild-Steel Electrode

A new all-position, mild-steel electrode, Airco No. 312, is designed primarily to prevent underbead cracking in the welding of hardenable steels. Laboratory tests and field applications indicate that this electrode is satisfactory for welding (1) low-alloy, high-tensile steels, particularly in heavy sections where preheat must be used with conventional-type electrodes to minimize cracking; (2) free-machining steels that normally run quite high in sulphur; and (3) cold-rolled steels where excessive porosity is normally encountered with conventional-type mild-steel electrodes.

For material to be vitreous-enameled after welding, this electrode is said to make possible production of satisfactory enameled surfaces without any preheat treatment prior to the enameling operation. It is stated that Airco No. 312 should also prove suitable on low-alloy or mild-steel applications where stress relieving would be desirable but cannot be accomplished either because of lack of facilities or the magnitude of the application. Air Reduction Sales Company, New York.

Optical Micrometer

The Aireon Optical Micrometer is intended to fulfill gaging requirements of plastics manufacturers and those who use plastics or glass in their fabrication.

When sheets of Lucite, Plexiglas, or plate glass to be measured are large, it becomes imperative to determine the thickness in the central portions of such sheets in positions inaccessible to the ordinary micrometer. The measurement of curved plastic sheet is difficult by ordinary means, since the ball head of the mechanical micrometer tends to sink into the plastic. Another problem arises when acrylic windows in airplanes must be measured for thickness. For these and similar cases, this new optical micrometer has been worked out on the principle of apparent depth.

Essentially, the instrument consists of a microscope that can be screwed up and down in an outer tube. The lower end of this tube is a plastic nosepiece that is held against the sheet to be measured. The transparent sheet is marked with a crayon on the side away from the instrument, and the measurement consists in sharply focusing the mark in the microscope. The readings on the barrel and thimble, just as in the case of an ordinary micrometer, give directly the thickness of the sheet. It takes just about the same time to obtain

the reading with this new instrument as with the purely mechanical instrument. Aireon Manufacturing Corporation, Burbank, Calif.

Electrical Connector

The WilliamsGrip electrical connector, embodying a new and simple principle for making quick, positive electrical contacts, is now available for industrial and aircraft use. Field tests, as well as tests conducted by a nationally recognized laboratory, are reported to have indicated that the new connector will reduce operational costs by as much as 30 per cent and is capable of solving 90 per cent of the current electrical-connector problems in industry.

The manufacturer states that the connector develops a perfect pressure contact. For emergency service, only a one-quarter turn by hand is required to make or break a connection strong enough to sustain a pull of 650 lbs. A permanent wrench connection will withstand a 1,600-lb. pull. The principle develops a pressure contact by means of expansion or contraction actuated by a special thread. Expansion or contraction is obtained through the medium of a metal body having the same special thread. When tightened a quarter turn, it climbs the connector thread pitch, thereby actuating the male or female shield. This causes a gripping action along the entire contact area.

The connector employs no springs, slip joints, or friction methods. Contact is reported to be so tight that at 100 amp. it has a maximum millivolt drop of only 1.9. With 100 per cent overload the connector operates from 5° to 25°F. cooler than the cable, as compared with the accepted standard of 9°F. above cable temperature at full-load current rating. Other features are listed as ease of installation; self-wiping action, eliminating arcing or excessive heating; reduction of corrosive action attributable to the contact area being entirely enclosed; quick, positive emergency connection and conductivity. AiResearch Manufacturing Company, Division of The Garrett Corporation, Los Angeles.

Aerial Mapping Equipment

Bausch & Lomb Mutiplex aerial mapping equipment, used by the Army to make accurate contour maps of large tracts of enemy territory, is now offered for sale to private firms and Government agencies as an economical method of mapping.

It is reported that Multiplex methods have been used successfully in civilian mapping projects by the U.S. Department of the Interior, Department of Agriculture, and other Government agencies. During the war, the Army used the equipment for making accurate maps of invasion beaches and for many other purposes.

In the Multiplex method, an aerial camera mounted in an airplane takes a series of photographs, each of which overlaps adjacent pictures by 40 to 60 per cent. From these negatives, usually 9 by 9 in. in size, small 2 by 2 in. transparencies called diapositives are exposed in the compact "reduction printer," a special copying camera. The diapositives are then placed in the Multiplex projectors, arranged in the order they were taken, and the overlapping pictures are aligned to form a series duplicating the angular relationships of the original negatives. As many as 14 projectors can be used together at one time.

Since alternate pictures are projected through red and green filters and the operators wear spectacles with green lenses in one side and red in the other, the projected landscape is seen stereoscopically in three dimensions. By moving a special tracing device over a sheet of paper, the operator can draw contour lines and other map features. A reading device on the tracing device enables him to measure quickly the height of any of the features photographed. Height measurements on photographs taken at an altitude of 4,000 ft. can be made accurate within 2 ft. of the original dimensions. The method is recommended by the manufacturer as being especially valuable for mapping large areas of inaccessible terrain such as are found in western deserts

ENGINEERS WANTED

AERODYNAMICISTS

Layout Draftsmen

Stress Analysts

with Aircraft Experience

To work in Engineering Dept. of Established Aircraft Company in New York Vicinity— Send resume to

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1457 Broadway,
New York City

When you write to manufacturers whose advertising appears in the **Aeronautical Engineering Review,** it will be of interest to the companies and of benefit to the Institute if you mention that you saw it in the **Aeronautical Engineering Review**

or in South America. The apparatus is portable. Bausch & Lomb Optical Company, Rochester, N.Y.

Flightphone, a Two-Way Communications Unit

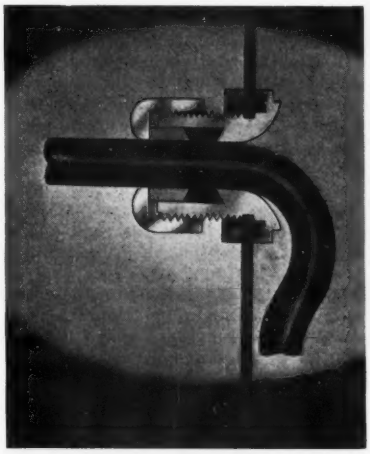
As its first two-way communications unit in the Flightweight line of radios for personal planes, the Radio Division of Bendix Aviation Corporation announces a five-channel, very high frequency transmitter combined with a range and broadcast receiver. This radiotelephone equipment, known as the PATR-10 Flightphone, weighs only 7 lbs.—including a built-in power supply, shock mounts, and range filter—and fits in a 5- by 7- by 7-in. space in the instrument panel. With the new instrument, which was designed to meet the requirements of the new program of the C.A.A. Federal Airways Service for private flying, an operator can talk from his plane to airport traffic-control towers and airway range stations and can listen to control-tower directions, radio-range signals, and also broadcasts. The distinctive feature of the transmitter unit is the use of very high frequencies. It is claimed that neither man-made nor atmospheric static hampers transmission to ground stations at distances of 75 miles or more, depending on the altitude of the plane. With the very high frequencies, maximum efficiency is obtained from only a 26-in. vertical antenna rod rather than the long trailing wire that has been associated with ordinary 3,105-kc. transmission.

Of the five crystal-controlled frequencies, two channels will be used at first—131.9 for all control towers and 131.7 for all civil airways stations. As additional frequencies are assigned by C.A.A., crystals may be plugged in for operation of the other three channels.

The receiver unit operates on a frequency range extending from 200 to 400 kc. and from 550 to 1,500 kc. The private flier is thereby in contact with airport control towers, civil airway stations, and range stations on the 200- to 400-kc. band. On the other band, the receiver picks up regular broadcast programs for entertainment or navigation.

Clear voice reception of weather reports and civil airways control is provided by a built-in range filter. Two watts of audio output provide enough power to permit efficient use of a loudspeaker as well as headphones. Another feature of the receiver designed is a delayed automatic volume control that prevents course reversal on range reception and overload on strong signals. The receiver may be tuned to the desired frequency through a 7:1 planetary drive while the plane is in flight.

With the addition of the Flightweight loop antenna, the receiver unit serves as an aural-null direction finder on either range or broadcasting stations. By means of a friction locking device, the loop may be locked at any point throughout its 360° of rotation. This loop is 11 in. high, 9 in. in diameter, and weighs only 20 oz. Bendix Radio Division, Bendix Aviation Corporation.



The new type of cable clamp manufactured by H. H. Buggie & Company.

Watertight Cable Lead-Through Clamp

A new type of cable clamp is stated not only to offer a secure and distortionless anchor for various sizes of jacketed cables but also to act as a barrier to any flow of moisture along the outside of the cable cover. Tightening the nut at the rear of the clamp places pressure on the internally mounted captivated rubber gasket through which the cable is passed. The angular wells of the cavity containing the gasket are so designed that pressure results in the rubber flowing inward to take an evenly distributed grip upon the cable. All metal parts exposed to contact with the cable are smoothly finished to eliminate any possibility of cutting the cable insulation even under the most severe conditions of vibration.

It is stated that neither the effectiveness of the clamp nor its watertight feature will be impaired, even though the cable be removed and reinstalled many times. Originally designed and used for both rigid and flexible coaxial lines, this same clamp is equally effective when used for radio leads and high- or low-tension line lead-ins or for any other lead-through where it is desirable not to cut the cable or line. H. H. Buggie & Company, Toledo, Ohio.

Portable Electric Infrared Equipment

Two new types of portable electric infrared equipment are designed for maximum efficiency and full flexibility. Both models are mounted on ball-bearing swivel casters for mobility.

The new Carbomatic W-6 type has a round, all-aluminum reflector, 24 in. in diameter, which may be raised or lowered as required, over the entire height of the stanchion. An adjustable arm permits changing the direction of the reflector over an arc of 180°. The unit is equipped with a heavy-duty extension cord.

The R-12 model accommodates twelve lamps and is equipped with three toggle switches, permitting the operation of one, two, or three rows of four lamps each. The unit is designed to accommodate up to three reflectors (of twelve lamps each) and is designed to enable the user to make up banks or tunnels of any design or shape.

Standard-make, reflector-type R40 or RE40 infrared lamps are used in both models, and either 125-watt or 250-watt lamps may be used. Carbomatic Corporation, New York.

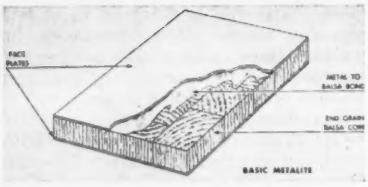
New Aircraft Structural Material

Metalite is a new lightweight material possessing great strength and an extremely smooth exterior. The new product is basically a metal-faced sandwich material employing a lightweight core to separate and stabilize the metal faces.

Engineers of the Chance Vought Division of United Aircraft Corporation believe that they have found in the new material a solution to the factors of wrinkling and parasite drag, which have limited the efficiency of the modern laminar-flow airfoil. Skin wrinkling, caused by the mass of air passing at high speeds over the surface of airplanes, can be reduced to a minimum without resorting to massive interior structure, since Metalite possesses great inherent rigidity, thus requiring fewer reinforcing members. The construction is expected to offer a new freedom from parasite drag, since whole panels can be fabricated with scarcely a single exterior protuberance to interrupt the airflow. In addition, it has important advantages for interior structures such as bulkheads and web sections, because its use permits simplification of structure by eliminating most of the conventional stiffeners and other auxiliary members. As a result of simplification of structure, a substantial reduction in the number of operations in production appears possible.

Metalite consists of thin sheets of high-strength aluminum alloy, separated by a thick, low-density core of balsa wood and bonded firmly together to form a single light, rigid unit. The grain direction of the balsa core is set perpendicular to the metal faces. A core material of greater density than balsa can be used in units where greater strength is desired. The core is relatively thick in comparison to the faceplates. The material is constructed by bonding the core and faces together under moderate heat and pressure, all the bonds being ordinarily made in one operation. The bonding operation is done with the parts or assembly in a mold of the desired shape.

For flat work, the parts are normally put together on a bench, and the whole assembly is placed in a mold afterward. For curved work, both single and double, several different forming methods can be used. Where only gentle curves are required, the work can be assembled flat on a bench and the entire assembly can be placed in a mold and forced into the desired shape by the application of pressure. Because of the thickness gained by the light core, the bending stiffness of a completed panel is many times greater than that of a simple sheet of



Drawing Courtesy Chance Vought Division, United Aircraft Corporation

A cutaway drawing showing the basic construction of Vought "Metalite." The face plates (thin sheets of high-strength aluminum alloy) are bonded to a core of end-grain balsa wood.

metal of the same weight. The hard metal faces cannot be damaged easily, and typical panels can be walked on without injury to the material.

Theoretic and experimental studies have been made on design standards for resistance of the metal faces to failure by local wrinkling, resistance of the core to failure by transverse shear loading, and resistance of the unit to failure by breakage of the bond between the core and metal faces. Investigations have been made with regard to the fatigue strength, resistance to large variations in temperature, and resistance to moisture and weathering. Chance Vought Aircraft Division, United Aircraft Corporation.

Improved Diecasting Machine

Complete elimination of cold metal from the shot furnace, improved hydraulic performance, automatic timing, and additional adjustable bearings for the movable platen are featured in the new Model 400 Universal high-pressure hydraulic diecasting machine. The new machine is available for casting zinc, tin, and lead or for magnesium, aluminum, bronze, and brass.

Although the manufacturer's basic design, including the interchangeability of hot metal ends, has not changed, the appearance of the machine is entirely different. All toggle and pump mechanism is entirely enclosed in steel guards. Ease of maintenance has been improved over previous models.

A double-compartment furnace on the zinc-tin-lead machine, with separate automatic burners for each compartment, eliminates cold metal in the shot compartment. New metal is placed in the second compartment, automatically causing the overflow of prepared molten metal into the shot section. Even temperature and uniform condition of the shot metal are maintained by this method. Improved uniformity in hydraulic performance is achieved by the addition of a new heat-exchanger oil cooler. The water-flow heat absorption is augmented by fin construction of the outer shell, which affords a high rate of heat radiation and provides a combination of air and water cooling. The constancy of hydraulic-oil temperature thus attained improves the uniformity of hydraulic performance.

Automatic timing has been made standard equipment and is combined with manual controls so that the method of operation may be selected in accordance with the type of production involved. All controls are centered on a single panel close to the operating station. New bronze adjustable wedge-type slide bearings have been added under the movable platen. These, sliding on hardened steel base strips, carry the full weight of the platen. This removes strain from the tie-bars, which now act merely as rigid guides, with large-area bronze bearings between the platen and the bars. The construction strengthens the platen assembly and helps to maintain accurate alignment of the die plates. The Cleveland Automatic Machine Company, Cleveland.

Lightweight Radio Transmitter

The Collins 17K-1 lightweight aircraft transmitter is a five-frequency, crystal-controlled transmitter for commercial and private aircraft use in the 122–132 megacycle band. The complete transmitter, including a dynamotor power supply, is housed in a single unit cabinet. Transmitter, control box, and interconnecting cable weigh less than 20 lbs.

Remote-control facilities allow complete freedom in locating the 17K-1 in the plane. An antenna transfer relay is available, if desired, in order to operate a receiver from the transmitting antenna.

The power output, adequate for the very high frequency range, is rated at 5 watts. Total power drain is held to a minimum during both stand-by and operation. The audio circuit employs peak clipping to raise appreciably the effective modulation level and to allow full use of the carrier power. Collins Radio Company, Cedar Rapids, Iowa.

Nine-Cylinder Radial Engines for Medium-Size Passenger Aircraft

Continental Motors Corporation has started production of a new nine-cylinder radial air-cooled airplane engine for postwar executive-type and medium-size transport planes to be manufactured by Beech Aircraft Corporation and Lockheed Aircraft Corporation. The new engine is reported to have a take-off rating of 525 hp. with direct drive and 600 hp. with a geared drive. The planes that it will power will carry from six to 14 passengers.

The engine is an improved version of the R-975 450-hp. radial engine built by Continental during the war years to power medium (30-ton) tanks, amphibious tanks, and Hellcat tank destroyers. It is claimed that power output and other performance characteristics have been greatly improved for airplane use. Continental Motors Corporation.

Segmental Lamination Dies

Segmental-type lamination dies that feature removable and replaceable punches and segments are stated to make possible substantial economies. The removable feature eliminates the necessity of replacing the entire punch built-up when one or more segments become worn; only the worn pieces need be replaced.

In addition to precision-made dies, the manufacturer maintains extensive facilities for the design and manufacture of a wide variety of tools, fixtures, and gages exactly to customers' specifications. A complete line of standard plug, ring, flat plug, profile, flush pin, snap, and build-up gages—all conforming to the latest American gage-design standards—is also available. These and special gages are supplied with or without carbide inserts and chromium plating. Crescent Tool & Die Company, Lincoln Park, Mich.

Flight-Control Device

The Simpli-Fly control system used in the Culver Model "V" involves the interconnection of certain controls (the interconnection causes the airplane automatically to trim itself for various flight attitudes). The flight-control wheel is located between the individually adjustable seats. Settings of the controls by means of that wheel are registered on the flight dial at the top center of the instrument panel.

The operation of the system may be compared to the operation of the gear shift of a car. For example, when the pilot wants to take off, he turns the control wheel to where the indicator on the flight dial points to "Take-Off," just as the driver engages the low gear to start. When the dial reads "Take-Off," the plane is automatically trimmed for take-off. Similarly, "Climb" corresponds to second gear and "Cruise" to high gear. In landing, "Approach" is equivalent to throwing out the clutch, and "Glide Control" corresponds to putting on the brakes. At every setting, the plane is automatically trimmed for optimum performance for that flight attitude.

The instrument panel has the full complement of standard flight instruments, dual control sticks, and conventional rudder pedals. The rudder need not be used in the air but is retained for use in cross-wind landing and take-off or in slipping into a short field. Culver Aircraft Corporation.

Floatplane Operations from Snow-Covered Fields

Operating his Edo-equipped floatplanes from a snow-covered surface during the past winter when the Connecticut River was frozen over, the operator of a seaplane base at Agawam, Mass., appears to have set a pattern for other operators who normally convert their floatplanes to skis or wheels when the ice begins to form. While the use of floatplanes for landings on snow, mud, and even dry ground is not an unusual procedure, general indications are that these "unorthodox" landings with floatplanes have been made under special conditions or as precautionary measures. As far as is known, this use of floatplanes is the first case reported of normal routine snow operations on Edo floats.

The operator has conducted near-normal student operations, checking out

private students. After a track has been made in the snow, the same grooves are used for subsequent take-offs and taxiing to the parking spot. A condition that was avoided as much as possible is rough snow that has become frozen, although the pilot took off once on the two icy strips still left on the otherwise bare field after the snow had melted away. The flexibility of the operation permits an immediate return to the river, which is usually thawed out by the time the field becomes so muddy that land operations are impossible, especially with wheels.

One of the first floatplane landings on snow in the New York area occurred several years before the war when a pilot landed a Fairchild on snow-covered Roosevelt Field. The landing was made as a precautionary measure after the plane had broken through the ice while taking off from a lake in northern New York. Fearing his floats may have been punctured, the pilot elected to land on the snow to avoid sinking. Inspection of the Edo floats after the snow landing revealed no damage to the bottoms.

Early in the war the A.A.F. conducted snow tests of an Edo-equipped 0–49 (later designated as the L-1) at Ladd Field, Alaska. Landings and take-offs were made with great success both from rough, hard-packed snow on the runways and in deeper snow. By using plenty of power and full rudder, the pilot found that the 0–49 could be turned in a radius of less than 100 ft. Edo Aircraft Corporation.

Small Motor Develops 2 Hp.

A compact and light Eemco 2-hp. explosion-proof motor is designed for aircraft, railroad, marine, and special industrial applications. An aircraft type, with armature speed of 9,000 r.p.m., the motor is particularly versatile in that it can be supplied for any output-shaft speed. An integrally built gear reducer, supplied when lower speeds are required, adds only 2 lbs. to the basic weight of 15 lbs.

The enclosure is stated to render the motor safe for use in hazardous locations. In addition, because it is so compact, it is well suited to such applications as fan and blower, pump, winch, and other drives, where high continuous-duty horsepower must often be fitted into an extremely small space.

This ball-bearing motor is completely insulated with the latest type of glass insulation and high-temperature varnishes. It can therefore be operated in continuous duty with a temperature rise of 75°C. over an ambient temperature of 25°C. It can be supplied for operation on 28, 32, or 110 volts d.c. Electrical Engineering and Manufacturing Company, Los Angeles.

Low-Voltage Electropneumatic Control Unit

The low-voltage (24 volts) Electro-Air control permits conversion of standard machine tools and fixtures to automatic or semiautomatic production units by pneumatic control of machine or fixing movement.

The manufacturer states that the control may be used with any standard air cylinder and can be arranged to provide either single- or multiple-cycle control with the addition of cycle timing, hesitation limit switches, etc., to perform a wide variety of operations such as automatic drilling, tapping, milling, indexing, holding, and others. Advantages claimed for the control are compact design, which permits mounting anywhere on the machine without hindering the movement or vision of the operator; absence of close-fitting ports or valves; reduction of accident hazard because of the low voltage employed; flexible application; and accurate, rapid control of any push-or-pull motion provided by high-speed action of solenoid-operated needle valves. Pressure selection over a wide range is rapid and accurate to provide exact pressure selection for the job and to assure economy in the use of air power.

The basic control unit consists of a step-down transformer (115–120 volts a.c. to 24 volts), manifold-type solenoid valves, pressure regulator, needle valves, and armature. Electro-Air Devices Company, Chicago.

The Fairey Spearfish

Full details are now released, following a series of successful first flights by the constructors' test pilots, of the new Fairey Spearfish torpedo and dive bomber, which at normal top load of 21,642 lbs. is said to be the largest aircraft yet to be ordered by the Royal Navy. It has been designed for multiple duties and in general terms is half as large again as its predecessor the Fairey Barracuda. It is equipped for all-weather flying in any part of the world and can be employed in defensive or offensive roles. Ability to carry a heavy-caliber torpedo, a variety of bombs, loads of mines, and the latest ultrasecret radar equipment place it in a special category among the world's aircraft. Its maximum range is more than 1,000 miles and its top speed is nearly 300 m.p.h.

The spacious dimensions of the oval-section fuselage permit its employment as a freighter or spares-transport aircraft. It can operate as a land-based general-purpose aircraft or from the deck of a carrier on all naval duties except pure combat. The wing span is 60 ft. 3 in., and the wings fold hydraulically to a breadth of 20 ft. As the propeller has five blades, it is convenient to give two dimensions for the height, with regard to hangar-stowage clearance dimensions: With the wings folded and tail wheel on ground or deck, the maximum overall height is 17 ft. 3 in., but, with the propeller arranged in its optimum position for stowage, the overall maximum height is reduced to 16 ft. 4 in. The overall length is 44 ft. 7 in.

The Spearfish is equipped with a Bristol Centaurus 18-cylinder, two-row radial air-cooled engine, Type C.E.58, giving a take-off power of 2,800 b.hp. with methanol and a maximum level output at 14,000 ft. of 2,320 b.hp. It is fitted with a Rotol five-blade propeller of 14-ft. diameter with constant-speed control. A feature of the aircraft is the compact installation of the engine that is almost totally enclosed in the cowl and gives the pilot an unobstructed forward view.

Accommodation is for a crew of two, and a midwing design has been followed. Both cockpits are covered by a continuous, transparent canopy that ends at a gun-sight cupola at the rear of the gunner's cockpit. The pilot's canopy is power-operated and designed to be jettisoned by the pilot in an emergency. An armor-plated bulkhead separates the two cockpits, but a small, hinged, transparent panel provides for direct communication between the two aircrew men.

With the need for clear forward view in mind, both for dive attack and deck landing, the Spearfish forward cockpit has been positioned high above the engine cowling so that the pilot has an uninterrupted forward view of 12° below the fore-and-aft line of the machine The windshield is bulletproof and, though set at a streamline angle, is optically flat. Ultraviolet lighting is installed for the instrument panel, and the same applies to the observer's cockpit. Navigation, radio, bomb, and torpedo-aiming instruments are installed in the rear cockpit. The observer's seat is rotatable and slidable, giving access to the remote control of the twin 0.5-in. Browning guns mounted aft of the cockpit.

Light alloy monocoque structure, with a fireproof bulkhead for bolted attachment of a tubular steel engine mounting, is the design for the fuselage. The monocoque is in three sections: (1) the forward and center plane, (2) the rear fuselage, and (3) the rear wedge. All are covered with light alloy skin panels flush-riveted to the frames and stiffeners. Beneath the aircrew's floors is a large bay in which is carried a torpedo or bombs and which is normally covered by bomb doors closed in flight but open for action. Radar is positioned in the "belly" of the aircraft and is constructed so that when not in use it can be retracted inside the fuselage.

Self-sealing main fuel tanks are installed in the center-section area, and a similar tank is housed in the starboard leading-edge structure. At the outboard ends of the rear spar are the hinge brackets for wing folding. The main landing-gear units retract outwards into the main plane.

Features of interest in the monoplane wings are the flaps and dive brakes. The flaps are of the Youngman high-lift airfoil type and extend from ailerons to fuselage. They can be set in four positions: housed, take-off, cruising, and landing. They play an important part in the rapid take-off and slow landing, as well as maneuverability-in-flight characteristics of the airplane. Vented dive brakes are fitted on the top and bottom surfaces of each outer plane.

the more they'll need *Equi-Tract**

As wing spans grow wider and distances from nose to tail increase, the need for control cables that are *not* subject to slackness at high altitudes, becomes more and more imperative. This requirement has been met by the development of U·S·S American ***Equi-Tract*** Control Cable.

For here is a steel cable in which the contraction and expansion differential between the airframe and the cable has been reduced by approximately 80%.

Thus ***Equi-Tract*** Control Cable makes it possible to retain control sensitivity at high altitudes with no need for mechanical compensators that add costly weight—without prefabricated harness that complicates handling—without the use of special fittings that require attention.

In short, ***Equi-Tract*** Control Cables—a new development in steel cable—provide improved *constant* control sensitivity from sea level to high altitudes. Makes possible standardized maintenance practices under difficult service conditions.

U·S·S American ***Equi-Tract*** Control Cable has been put through its paces, and enthusiastically accepted, by leading American aircraft builders. Our engineers will gladly discuss its application to your designs.

*The steel control cable that retains control sensitivity at high altitudes.

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

Columbia Steel Company, San Francisco, *Pacific Coast Distributors*
Tennessee Coal, Iron & Railroad Company, Birmingham, *Southern Distributors*
United States Steel Export Company, New York

UNITED STATES STEEL

AMERICAN STEEL & WIRE COMPANY — USS — AMERICAN *Equi-Tract* CONTROL CABLE — UNITED STATES STEEL

U·S·S American "EQUI-TRACT" *Control Cables*

The "tail-sting" arrester hook and mechanism is situated at the extreme end of the fuselage When housed, it is stowed hook forward and is secured by a snap mechanism at the forward end of the port tail-wheel door. The snap mechanism is manually operated by the pilot. A special feature of this hook is the design for restowing after use, a simple release clip enabling it to be folded sideways, thus clearing the deck or ground.

All exterior surfaces are of stressed-skin metal construction, except the rudder, which is fabric-covered. Trim and spring tabs are fitted to all control surfaces. By a simple mechanical linkage, the tail wheel operates its own doors when extending or retracting.

According to employment, a diversity of war loads may be carried, including torpedoes, bombs, depth charges, flares, and a long-range fuel tank. In addition to four 0.5-in. Browning guns, two in the wings firing forward and two aft, 16 rockets projectiles may be carried externally beneath the outer planes. When the aircraft is used for dive bombing, a special bomb ejector is installed in the bomb bay. This, when in operation, throws the bomb well clear of the aircraft even at its steepest angle of dive. The Fairey Aviation Company, Ltd.

Concentrated Washing Compound

BEX UT-30 is an amber liquid which, extended with 10 to 500 parts of water, is prepared for the purpose of safely and thoroughly cleaning any surface to which water may be applied. It is odorless; is chemically neutral; and has no adverse effect on skin, cloth, metals, or plastics. Upon dilution with water, it forms a stable mixture. The material weighs about 8 1/4 lbs. per gal. If necessary in exceptional cases, it may be used in concentrated form without risk.

Exact dilutions for each particular use may be found by experimentation. In general, however, it has been found that, for heavy duty such as cleaning shop floors or engines, dilution with 10 parts of water is successful; for medium duty, 50 to 100 parts of water may be added; and for light work, dilution may be 80 to 250 parts. The compound is available in 5- and 54-gal. drums. Gaybex Corporation, Nutley, N.J.

Poppet-Type Hydraulic Check Valve

Use of lightweight metals, simplified design, and precision machining have made possible the production of a new Greer poppet-type check valve. The unit is composed of a valve housing, a hollow aluminum-alloy poppet and guide, a valve spring, and a "True-arc" retaining ring.

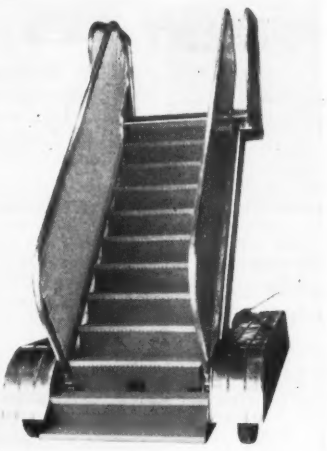
The valve is reported to have completed a 50,000-cycle test, fully open to fully closed, at 2,000 lbs. per sq.in. without appreciable wear on either the poppet or the seat. Greer Hydraulics, Inc., Brooklyn.

Passenger-Loading Stand for Airplanes

The Vari-Stand, for passenger loading and unloading, has hand-rails made of 2-in. polished aluminum tubing. The fenders are made of highly polished aluminum, and the base is of all-steel construction. The treads and risers are available in five different colors and are made of Goodrich "Avtrim."

For ease of operation the stand has a hydraulic lift with a locking safety feature, a pawl and ratchet that remains at the automatic safety position at any height. It is equipped with Bassick F-400 truck locks. The tires are of the pneumatic or molded-rubber type.

A special feature incorporated in the design of the stand is that the steps are always level, regardless of the angle of the stand, making it adaptable for many maintenance purposes. Sideway is eliminated by a specially designed feature in the construction of the chassis and superstructure. Hammond Manufacturing Corporation, Huntington Park, Calif.



Hammond Manufacturing Company's passenger-loading stand for airplanes

Baggage Cart for Airports

A baggage cart of universal type is available for use by air lines and airports and for other carrier operations. The dimensions of the cart are 3 by 6 ft., and its capacity is 1,200 lbs. It is made of highly polished aluminum and is lined with plywood for extra strength.

The cart has retractible couplers fore and aft for convoy use, and it may be used with fork-lift trucks or by itself. Standard equipment is a chromium bumper, Bassick foot-operated truck locks, and manually controlled brakes. Hammond Manufacturing Corporation, Huntington Park, Calif.

New Thermonic Multiturn Split Coil

Induction hardening of localized surfaces of such parts as crankshafts, camshafts, and similar components is reported to have been simplified by the Thermonic multiturn split coil. Where the design of the part to be hardened prevents it from being placed within the conventional type of induction-heating coil, as is the case with a crankshaft, a split-type coil must be used. Simple single-turn split coils have been used for a considerable time, but, where diameters are relatively small, such as 1 in. or less, it is necessary to use coils of more than one turn in order to provide sufficient energy transfer to produce the results inherent in the induction-heating process.

The new coil consists of two or more turns, made up of machined copper plates, which are split and hinged in such a manner as to allow the coil to be opened. The work is inserted in place, and the coil is closed and clamped, automatically making contact between the segmental sections to provide a continuous path for current flow. The segments of the coil are held in relationship to each other by an insulating retainer ring that runs around the outside of the coil and forms a closed passage between the coil turns.

When hardening operations are to be performed by use of the coil, this passage can be utilized to carry the quenching medium to the heated metal without removing the work from the coil. This also eliminates the time delay between the end of the heating process and the start of the quench, which is always present when the work must be removed from the coil prior to quenching. Thus, full advantage of the surface effect of high-frequency induction heating can be obtained, since excessive thermal conduction into the heated part is prevented. Since both the coil segments and the supporting leads are independently water-cooled, the coil may be used without internal quenching, permitting continuous operation for all applications.

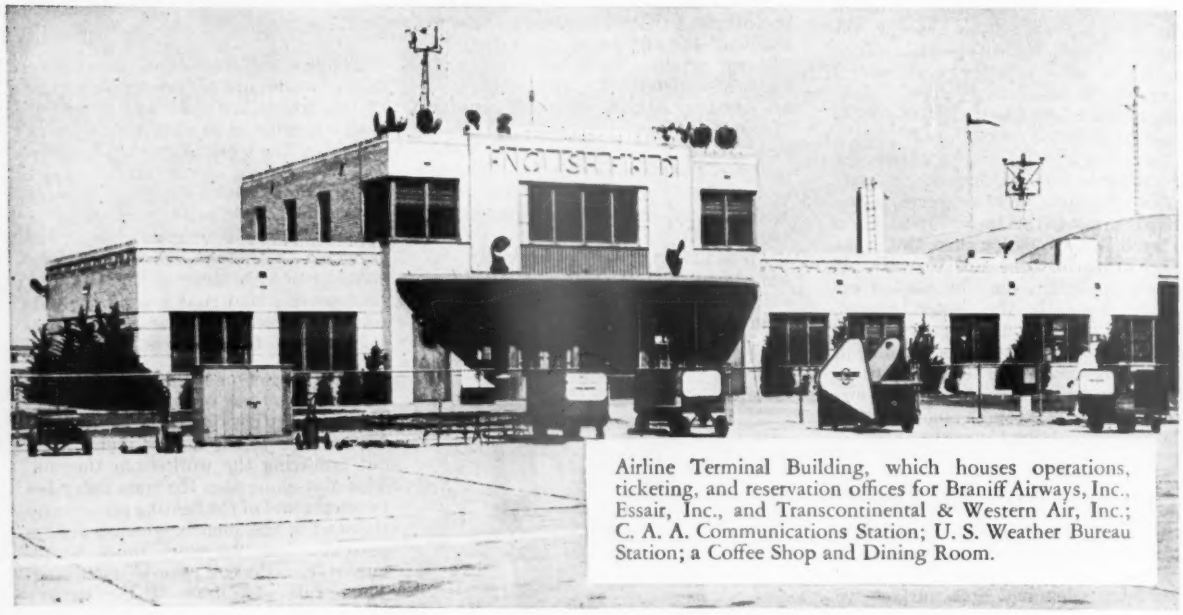
The coil is stated to have many applications—(1) in crankshafts, where each journal is hardened individually; (2) in camshafts, where the shaft is progressed and each cam is placed successively in the coil; (3) in shafts having large sections or flanges at their ends which prohibit the use of ordinary types of induction-heating coils; (4) in brazing and annealing of sections that require split-type coils.

Such a coil has enabled manufacturers of small-diameter crankshafts to harden their journals to a depth of twenty to thirty thousandths of an inch, to obtain similar results on camshafts, and to perform brazing operations on assemblies such as hubs to shafts where the hubs are of greater diameter than the shafts.

Power concentrations as high as 20 kw. per sq.in. on 1/2-in. diameter shafts are made possible by use of the split coil, resulting in hardened cases of 0.020-in. thicknesses when used with Thermonic induction-heating equipment having an output frequency of 375,000 cycles. Induction Heating Corporation, New York.

ENGLISH FIELD, *Amarillo, Texas*

"THE FRIENDLY FIELD" IS A GOOD FRIEND OF PHILLIPS!



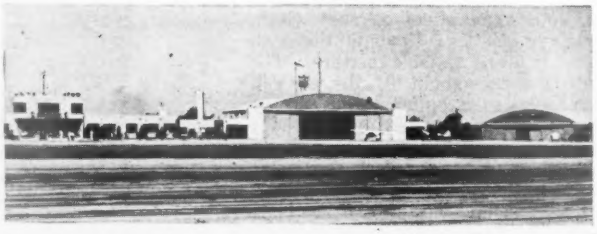
Airline Terminal Building, which houses operations, ticketing, and reservation offices for Braniff Airways, Inc., Essair, Inc., and Transcontinental & Western Air, Inc.; C. A. A. Communications Station; U. S. Weather Bureau Station; a Coffee Shop and Dining Room.

FOLKS who fly the Southwest will tell you that for courteous, personal service and friendly goodwill, there's no place that can beat English Field at Amarillo!

Blessed with excellent terrain and a high percentage of flying weather, its modern facilities serve an increasing number of private planes.

In addition, English Field handles four scheduled flights of Braniff Airways, Inc. per day; and an average of twenty-six flights of Transcontinental & Western Air, Inc. per day.

We're proud that this "friendly field" is a good friend of ours. Here's why: What *others* think about Phillips Aviation Gasoline and Phillips Service is a darn sight more important to *you* than what we think about ourselves. The tip-off on any product is the kind of people and places that use it. We've *earned* ourselves some mighty good friends. Maybe we can be of service to you, too. If you have a problem that involves aviation fuel—write to us at the Aviation Department, Phillips Petroleum Company, Bartlesville, Oklahoma.



Above—Panorama of buildings on English Field showing, from left to right, Airline Terminal Building, Private Fliers Terminal Building, Hangar No. 1, and Hangar No. 2.

At left—C. H. Knupp, one of the people who helped make English "the friendly field" has been Airport Manager for the past 11 years.

Phillips
AVIATION GASOLINE

Slide Films About Fluids

The Jam Handy Organization announces the completion and availability of 1,042 pictures in the form of 13 discussional-type slide films titled *Fluids*, a continuation of the Air Age Physics series which began with the kit-set on mechanics. Each film unit is divided into lessons. Each lesson is followed by review and quiz sections. The following subjects are covered in the set: Liquid Pressure; Transmitting Pressure Through Liquids; Buoyancy and Archimedes' Principle; Density and Specific Gravity—Flotation; Specific Gravity of Solids and Liquids; Atmospheric Pressure; Exploring the Atmosphere—Streamline Flow; Barometers and Weather; Gas Pressures; Measuring Fluid Pressure; Bernoulli's Principle; Reciprocating Pumps; and Jet Pumps, Siphons, Rotating Pumps. The Jam Handy Organization, Detroit.

Kaiser-Hammond Family Plane

Preliminary details of the new Kaiser-Hammond family plane reveal that it is a low-wing, four- or five-place monoplane powered by a 220-hp. engine and pusher-type propeller. The plane will be of the "spinproof," "stallproof," type, with cruising speed of 140 m.p.h. and cruising range of 600 miles. It is stated to provide improved vision range and other safety features.

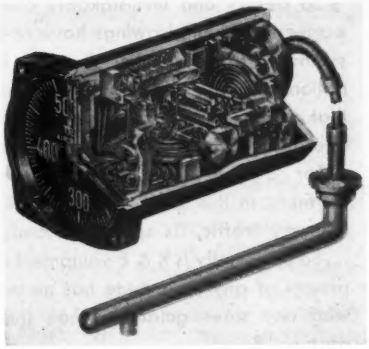
Although the airplane has been successfully flight-tested, no plans have been announced as to where it will be produced, its selling price, or approximate delivery date. Estimates of production costs in various possible production centers are now being prepared as a basis for determining the place of manufacture. Henry J. Kaiser Company, Oakland, Calif.

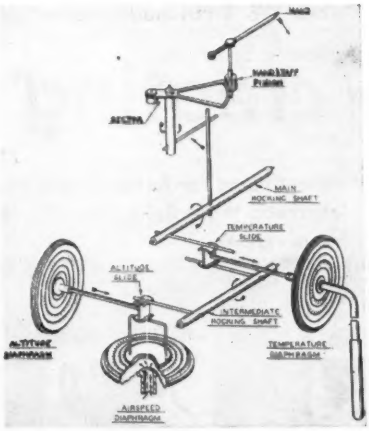
True Air-Speed Indicator

With the new Kollsman True Air Speed Indicator, accurate indication of the exact speed in miles per hour at which a plane is flying is immediately available to flight crews, eliminating the present method of involved computations and the many possible sources of human error.

Of great military significance during the war, especially during precision-bombing operations, the indicator has many advantages to offer to commercial aviation in the present age of multi-engined aircraft and substratosphere flight. These include its use by the pilot or navigation officer as an aid to long- or short-range navigation and by the engineering officer for accurate and efficient cruising-power control. Because true air speed is correctly indicated regardless of altitude or temperature, it also is a logical instrument to be installed in cabins for the information and enjoyment of passengers. The manufacturer has recently developed large, oversized instruments for this purpose.

The True Air Speed Indicator basically consists of three separate units—air-speed indicator, altimeter, and air thermometer—combined in one interacting assembly. Among the advantages it is stated that the direct indication of true air speed supersedes the present method of taking separate readings of indicated air speed, altitude, and outside air temperature and then arriving at a figure through computation; it is unnecessary to apply corrections as changes occur in air density; it provides a value free of human error; and corrections are made for the compressibility effect of the air stream on the instrument-actuating intakes mounted outside the plane, thus providing a degree of accuracy not possible with older methods. Because compressibility phenomena are more active at high speeds, this factor will grow in importance with improved aircraft. Kollsman Instrument Division of Square D Company.





The True Air Speed indicator manufactured by the Kollsman Instrument Division of Square D Company. The cutaway view shows the relative location of the components of the indicator. The lower diagram is a simplified representation of the operation of the instrument.

Dynamometers for Fractional-Horsepower Measurement

New dynamometers replace Prony brakes for quickly measuring torque and horsepower of all types of fractional horsepower motors and are of the eddy current type with d.c. excitation. Torque loads are varied by rheostat adjustment. The dynamometers are credited with being more accurate and convenient than Prony brakes. They are intended to save time in both laboratory and production use because they are self-damping and self-cooling, are designed for uninterrupted and continuous service, and permit one-man operation. Mounted on an ample base, they are adapted for speedy production setups and are suitable for testing electric, hydraulic, or pneumatic motors or internal-combustion engines and flexible-shaft transmissions.

The dynamometers have no springs or frictional devices and maintain unvarying torque readings for long runs. Either running or stalled torques are easily measured. The smallest sizes measure torques accurately at speeds up to 15,000 r.p.m. and up to 10 oz.-in. Other sizes measure up to 25 in.lbs. Additional capacity is obtainable with external cooling and for short runs. L.A.B. Corporation, Summit, N.J.

Pipe-Joint Compound in Stick Form

Pipetite-Stik is a pipe-joint compound in stick form. All that is necessary is to make three or four strokes of the stick across pipe threads. It spreads and fills the threads when turned. Encased in a convenient cardboard holder, the stick may be carried in a pocket or tool kit, ready for instant use.

The manufacturer states that the material withstands gasoline, oil, butane, propanes, Freon, air, water, steam, acid, gas, brine, sulphur dioxide, etc. Joints can be disconnected easily after applying. The material lubricates and seals pipe-joint threads, nuts, bolts, gaskets, turnbuckles, etc. It cannot flow into and clog even the smallest-size pipes, and it withstands vibration, temperature changes, deflection, and pressure. Lake Chemical Company, Chicago.

New Protective Coating Solves Corrosion Problems

A new protective coating is highly resistant to acids, alkalies, chlorides, oils, brine, oxygen, gasoline, and alcohol solutions. Called "Cotoid," it is a recently developed formula based on synthetic resin—a thermoplastic—in which low water absorption and inert properties inhibit corrosion.

The application of Cotoid is said to result in a tough, hard, elastic finish, which, after air or force drying, is tasteless and odorless. It has been found practicable for protecting walls and wood or steel structural work. It can be used for coating inside and outside surfaces of concrete, steel, or wooden tanks used for corrosive solutions, brines, and alkalies. It has been laboratory-tested and approved for use with a wide range of acids, gasoline, sour crudes, and lye solutions.

Cotoid will withstand a maximum temperature in air or vapor of 220°F. Maximum submerged temperatures approach 150°F. It will not crack under temperatures as low as −20°F.

Application by spraying is recommended by the maker. It can be applied by dipping, flowing, or roller coating. A specially prepared Cotoid for baking-on process is available. Cotoid

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is packaged in 1-, 5-, and 10-gal. cans and in 55-gal. drums. Lithgow Corporation, Chicago.

High-Performance Light Plane

Public appearance of a new, experimental, high-performance light plane, was announced by the Luscombe Airplane Corporation. This "Model 10" plane—a low-wing, all-metal monoplane designed to carry one person—is powered by a four-cylinder, air-cooled Continental engine of 65 hp., which gives it a top speed of more than 135 m.p.h. and a cruising speed of 122 m.p.h. At cruising speed the engine reportedly consumes only 4 gal. of gasoline per hour.

Construction of the plane features the extensive use of parts that Luscombe is already employing in production of its standard two-place 65-hp. Silvaire. The fuselage of the Model 10 is of aluminum stressed-skin construction with few bulkheads. It has a fabric-covered, internally braced metal wing and metal-covered control surfaces. A bubble-type cockpit canopy and wing-root fillets are employed for maximum streamlining effect. The landing gear is fixed, with oleo shock struts. The plane's wingspread is 25 ft. and its overall length is 17 ft. It weighs 845 lbs. fully loaded. Luscombe Airplane Corporation.

Aircraft-Range Receiver

The Maguire aircraft range receiver, Model ARR-1, was designed for permanent installation as the sole radio equipment in light aircraft or as a standby emergency receiver for the larger airplanes that are equipped with a two-way radio. It is equally adaptable, however, for portable installation in all types of planes, since the batteries are contained in the same case as the receiver and there is only one external plug-in connection necessary to place the set in operation.

Features claimed for the receiver include ruggedness; light weight; noise-free reception, even though installed in a plane with an unshielded engine; and low initial cost and cost of operation. The set, complete with tubes and batteries, weighs only 3 lbs. 10 oz. and measures only $4^1/_8$ by $4^1/_2$ by $6^3/_4$. The batteries are readily replaced. Since the most recently developed low-battery-drain miniature tubes are used, the "A" battery is expected to supply more than 30 hours of flying service, while the "B" battery will last more than 50 hours. A voice filter has been designed and built into the receiver. By the operation of a switch, the 1,020-cycle range note is reduced to a minimum, which results in clear reception of voice instructions and weather reports. In addition to weather and tower signals, the Model ARR-1 will receive all radio ranges in the 190- to 420-kc. frequency band. Under average conditions, the range of the receiver is better than 150 miles. An accessory kit comprising "A" batteries, "B" battery, headphones, and plug is supplied by the manufacturer at slight additional cost. Maguire Industries, Inc., Bridgeport, Conn.

Automatic "Blind-Landing" Instrument

Automatic "blind" landing achieved a step forward when the Minneapolis-Honeywell Regulator Company and the Civil Aeronautics Administration revealed the operation of a "black box" that can automatically guide an airplane to a safe landing by means of very high frequency radio waves. Foreshadowing uninterrupted flight schedules to fog-bound airports, the system of control is reported to have been tested successfully in more than 1,000 low-altitude approaches without manual steering of the airplane.

The new automatic approach system was developed to overcome the low-visibility conditions that previously have interfered with air travel. It picks up beamed radio waves that "cut a road through the sky" and follows them down to the airstrip. It is stated that automatic landing equipment can be installed in all aircraft equipped with the radio instrument-landing system developed by the Civil Aeronautics Administration. The device is a specialized radio receiver in which signals from transmitters located on runways are fed to an electronic automatic pilot, which, at a turn of a switch, takes over the pilot's flight duties, leaving him free to control engine power, lower flaps and wheels, and handle the other duties of landing.

Called the Automatic Approach Coupler, the instrument is actually an accessory to the electronic autopilot. It consists of a radio receiver permanently tuned to receive special signals from airport transmitters and an amplifier that interprets the signals and feeds them to the autopilot. The latter instrument moves the flight control surfaces in response to the signals with a speed and accuracy of response greater than that possible for a human pilot.

In use, an airplane is flown either on the autopilot or manually to within a short distance of the "closed in" field at which it is scheduled to land. When close to the field the instrument picks up radio waves emanating from marker beacons and indicates this contact by a flashing light. When he sees this signal, the pilot throws a switch on the autopilot which immediately puts the plane under flight control of "localizer" beams being continuously transmitted from the airport. The plane is then automatically guided toward the landing strip until a second signal indicates that it has intersected an additional, or "glide path" beam, which is also necessary for instrument approach. The pilot then throws the switch to another position, putting the plane under control of both the glide path and localizer beams and steering it toward the landing field at a fixed rate of descent until it makes contact with the runway. A disengaging button, permitting instantaneous release of the automatic system, is attached to the pilot's control wheel, giving him manual operation if visibility clears within a few feet of the ground; otherwise the system is capable of bringing the airplane in without pilot aid except to cut the engine switches and apply the brakes when ground contact is made.

Another plug-in accessory connects the radio compass with the autopilot, making "push-button" flight between cities a practical achievement. Under this application, the signals from the compass which is tuned to the city of destination, are fed to the autopilot and fly the airplane in a straight line for hundreds of miles. Minneapolis-Honeywell Regulator Company.

Pneumatic Three-Way Pilot Valve

A new Modernair three-way pilot valve is designed for use in the application of controlled air power to machine tools. Called the CRV pilot valve, the unit can be used either as a three-way valve, normally open or closed, or as a two-way valve, normally open or closed. Installation as a two-way pilot valve is accomplished by simply plugging one port. The valve is compact, being $3^1/_4$ in. overall with the piston fully extended.

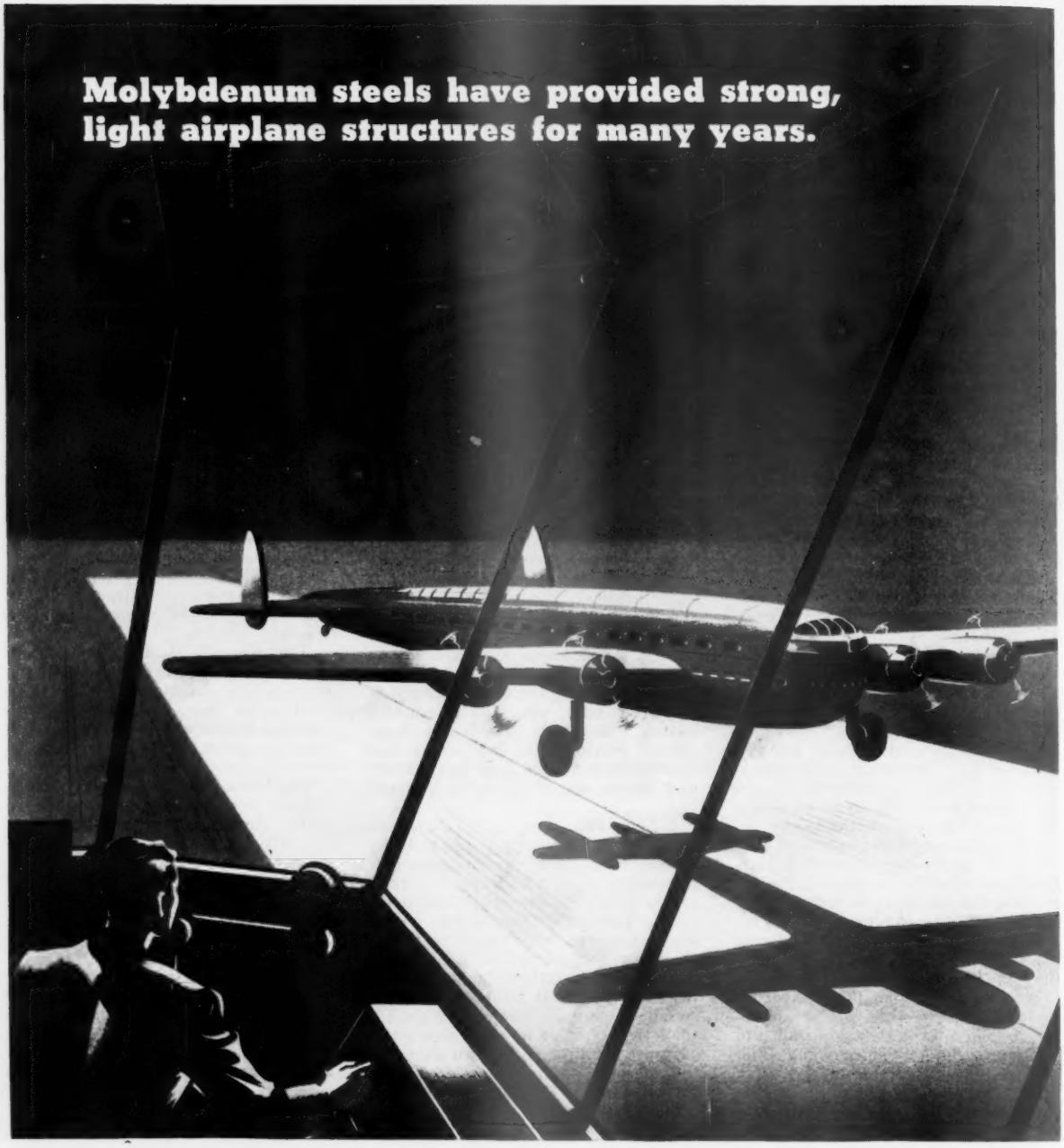
The valve is used to operate air cylinders, air motors, air controls, and single-acting cylinders such as those used on air vises, air chucks, etc. In addition to compressed-air operation, it may be used in low-pressure hydraulic control and actuating systems.

The design utilizes aircraft-type packings on the piston rod as the bearing points, eliminating metal-to-metal contact within the valve. This results in smooth and positive operation over long periods without servicing. The valve is completely renewed by simply replacing four "O"-ring packings.

It is said to be impossible for the plunger of the CRV pilot valve to come out of the housing during installation or operation. The piston rod is retained by an end plate, eliminating this difficulty. The end plate is readily removed without breaking any connections, whenever packing replacement is necessary. Another feature of the unit is the fact that it is fully balanced, operating freely under conditions of extreme pressure variation. The valve is normally supplied with $^1/_8$-in. inside pipe thread ports. However, other sized ports or threads may be obtained. Modern Products, Ltd., Los Angeles.

Optical Measuring Instruments

Uniformly accurate measurements of gage blocks, anvils, sealing surfaces, and other precision articles are claimed for the new Optron Interference Viewer. The interference patterns are both illuminated and viewed on a line perpendicular to the plane of the pattern. Distortion of the pattern is reported to be eliminated. Each pattern appears the same to different observers, thus simplifying inspection of one pattern by several observers and removing the



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chief problem that has hitherto made instruction in optical measurement techniques difficult.

The monochromatic light source in the viewer is completely concealed, relieving eyestrain. The type of light source used in the viewer (with a wave length of 20.8 millionths of an inch) was selected to give interference patterns maximum brightness and sharpness. The device incorporates a feature enabling the user to superimpose the image of any convenient scale on the interference pattern itself, permitting convenient comparisons of straightness or direct measurements between interference bands without using a ruler or straight edge.

The equipment is also credited with being the only commercially available device that permits the use of Haidinger bands in tests for parallelism without accessories of any kind. Deviations in parallelism from $^1/_2$ to 15 sec. can be readily observed.

It is claimed that checking of gage blocks, anvils, sealing surfaces, and other precision articles for flatness, size, and parallelism is made simpler, more accurate, and more convenient by the use of the Optron square and rectangular optical flats. In addition, these new flats are credited with being economical and easy to handle. For example, a 10- by $2^3/_8$-in. flat can be used in place of a round flat 10 in. in diameter; it weighs one-fourth as much and can be safely handled with one hand.

The straight edges of the flats provide reference lines for comparison of straightness of interference bands, often making it unnecessary to use rules or straight edges and removing another possible cause of scratching the fine surfaces.

The instruments are guaranteed by the manufacturer to be flat within one-tenth wave (2 millionths of an inch). They are made in square form up to 6 by 6 in. or in bars up to 10 by $2^3/_8$ in. Optron Laboratory, Dayton, Ohio.

Piper J-5 Super Cruiser

The new Piper J-5 Super Cruiser, designed as a utility airplane for the private flier, has been released by the Civil Aeronautics Administration both as a small transport and as a trainer plane.

As a small transport, the Super Cruiser has been licensed to fly at a gross weight of 1,750 lbs., which includes the pilot, two passengers and baggage, and sufficient fuel for a 6-hour flight. When used as a trainer, the new model can be flown at a gross weight of 1,500 lbs. This weight includes pilot, student, and 4 hours' supply of fuel. The J-5 is equipped with dual controls for student training.

A three-passenger monoplane, it has a cruising speed of 100 m.p.h. and a top speed of 120 to 125 m.p.h. It is equipped with a 100-hp. engine and an electric starter and generator. [1] Piper Aircraft Corporation.

Portable Magnet Charger

The RFL Model 107 magnet charger is a commercial version of a model first built for the armed services. It is designed for use in production lines, instrument repair shops, and laboratories. It contains a large-capacity condenser, an associated power pack, and a current transformer through which the condenser bank is discharged. The transformer secondary is connected to a charging bar that is arranged for convenient association with the magnet for induction of the charging magnetic flux. The condenser charge is controlled by an ignitron-type tube operated by a push button on the front panel.

The storage condenser bank has a capacity of 100 microfarads and is charged to approximately 500 volts. When the ignitron-type tube is fired, the condenser discharges in a small fraction of a second, producing a high current surge in the charging bar exceeding 15,000 amp. peak value.

The unit measures 7 by 12 by 17 in. and weighs 75 lbs. It is portable or may be bolted to a bench for production operations. It takes power from a 110–120-volt, 50–50-cycle a.c. service power outlet. Radio Frequency Laboratories, Inc., Boonton, N.J.

Two-Way Radio for Personal Aircraft

A new two-way personal-plane radio, designed to utilize the outstanding features of both low frequency and very high frequency (VHF) airways facilities, is being manufactured by Raytheon Manufacturing Company. Total weight of the transmitter and receiver is 14 lbs. Dimensions are 5 in. high, $5^1/_4$ in. wide, and $14^1/_4$ in. deep.

By incorporating a fixed tuned VHF channel on 75 megacycles for receiving fan and Z markers and continuous tuneable coverage from 195 to 410 kc. and 540 to 1,600 kc., the most satisfactory communications and navigation are said to have been achieved in one unit. A loop antenna may be added to provide radio direction-finding navigation. Transmitter operation is on the standard private-aircraft frequency of 3,105 kc. The Radiophone is not an interim piece of equipment for either low frequencies or very high frequencies; it is stated that satisfactory service will be provided on all proposed airways.

Transmitter and receiver are combined in a single compact unit. The entire unit may be installed or removed in a matter of minutes. Initial installation is simple and includes such conveniences as built-in loading coils and built-in power pack. Receiver performance is reported to be comparable to commercial air-line standards. The superheterodyne circuit incorporates a stage of radio-frequency amplification providing high sensitivity to weak signals. Optimum performance on both tuneable bands is afforded by a volume-control circuit controlling the radio-frequency sensitivity on the range band and the audio gain in the broadcast band.

Incorporated in the receiver is a range filter permitting filtering out of voice transmissions from "A" and "N" quadrant identification signals when using the standard simultaneous-type Civil Aeronautics Administration radio ranges. This is a valuable feature when reading scheduled weather broadcasts sent out on almost all range stations.

The transmitter circuit has a high output—14 watts is available—to ensure communications over extended ranges and adverse radio conditions. No separate loading unit is required. Self-contained in the transmitter are all necessary loading circuits for use on any type of aircraft radio antenna. A further feature is the use of an ingenious circuit that provides perfect indications on 75 megacycles without the employment of a separate antenna.

Push-to-talk control of the transmitter is provided by a push button on the microphone. At the same time the transmitter is turned on, the side-tone circuit is completed, enabling the pilot to monitor his own transmission and check the operation of the transmitter. Radiation and modulation are continuously indicated on the front panel.

The Radiophone is available in three different models to operate from a d.c. input of either 6, 12, or 24 volts. Two independent vibrators are included with a selector switch on the front panel in the event of failure of either unit. Provisions are made for a loop antenna, which can be supplied at a slight additional charge. Raytheon Manufacturing Company, New York.

Multipole-Type Relay for Electronic Application

The RBM Series No. 98330 is a new midget a.c. multipole relay with shunt coil for electronic and communication applications. Standard voltage range is from $1^1/_2$ to 220 volts, 60 cycles. Contact arrangements are available for one to four poles, normally open, normally closed, or double break. The double-throw contacts can be of the "break-before-make" or "make-before-break" type. Maximum contact rating, noninductive, is 3 amp. at 24 volts a.c., or 1 amp. at 110 volts. Coil rating is 11 volt-amp. inrush and 5 volt-amp. sealed. This relay is available also with single-pole normally open, double-break contacts, 10-amp. rating, at 115 volts a.c.

The approximate overall dimensions are $1^{61}/_{64}$ in. long; $1^{34}/_{64}$ in. high (four-pole double-throw); $1^{35}/_{64}$ in. wide. The heel piece of the magnet frame has two tapped holes for rear mounting and two pierced holes for front mounting. Solder-type terminals are provided. R-B-M Division, Essex Wire Corporation, Logansport, Ind.

Locking Caps for Fuel Tanks

Positive locking airplane fuel-tank caps, incorporating the patented Roylyn coupling principle, provide a 4-in. diameter hose clearance with an overall diameter of $5^1/_2$ in. Tests made on the cap show no leakage at pressures up to

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HYDRAULIC VALVE LIFTERS

provide

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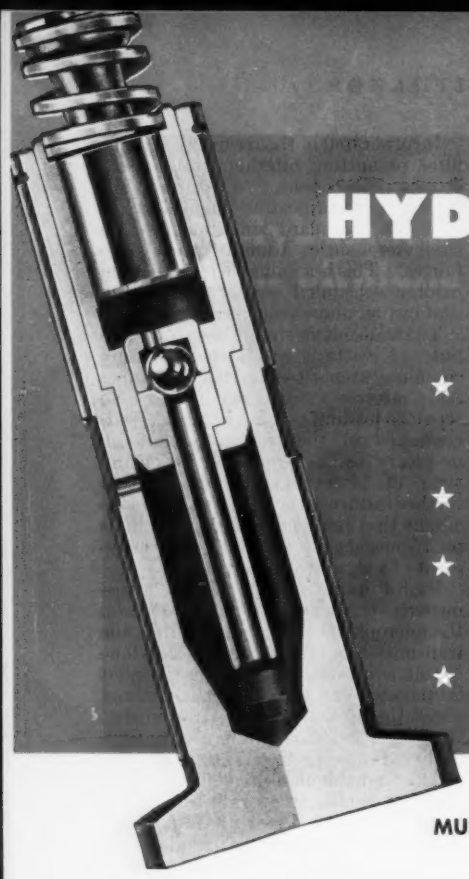
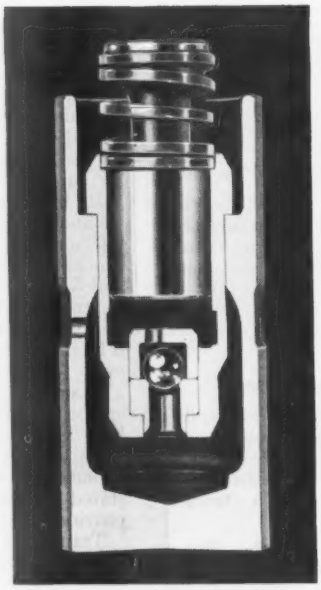


MUSHROOM TYPE

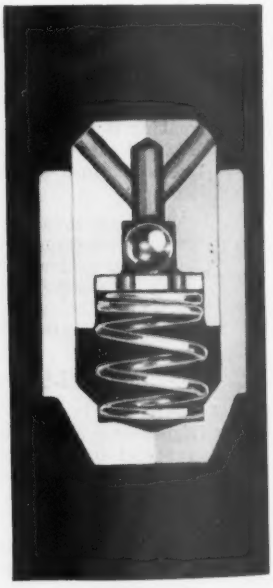
The *Zero-Lash* Hydraulic Valve Lifter is a simple, positive-action device, which automatically adjusts its own length during each revolution of the camshaft to compensate for expansion or contraction in the valve train. It is available in three basic types—mushroom, barrel, and stub—which are adaptable to all internal combustion engines, gasoline or Diesel.

In addition to improved engine performance, longer service life for valve train parts, and silent operation, *Zero-Lash* Hydraulic Valve Lifters eliminate the need for adjustment, and permit the simplest and most advantageous engine design.

Eaton engineers will be glad to discuss the application of *Zero-Lash* Hydraulic Valve Lifters to engines now in design.



BARREL TYPE



STUB TYPE

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Illustrated literature covering the design and operation of Zero-Lash Hydraulic Valve Lifters, including reports of outstanding service records, will be furnished upon request.

EATON

MANUFACTURING COMPANY

WILCOX-RICH DIVISION

9771 French Road • Detroit 13, Michigan

35 lbs. per sq.in. at sea-level conditions, according to an announcement by the manufacturer.

Both the recessed and flush-type models consist of a base and cap, the latter containing a cam, ball cage, and gasket. When the cap is positioned for locking, a quarter-turn activates the cam collar, forcing steel balls inward against the groove in the base and locking the halves together. The gasket, retained in the ball cage, provides a positive seal as well as acting as the separating spring force required to operate the lock.

Vibration will not spring the lock because nothing but relief of the cam will release the pressure on the groove. Both visual and audible checks indicate the position of the cap. Provisions for a safety chain and fuel strainer are included. The Roylyn stainless-steel strainer, which fits into the cap base, ranges in length to 30 in. and will not collapse under normal fuel surging.

Smaller sizes of the positive-lock cap will soon be ready for oil, hydraulic, and other tanks in airplanes. Roylyn, Inc., Los Angeles.

Height Gage with Long Vernier

The 48-in. Chesterman height gage employs an extra large vernier measuring 2.450 in. long, as compared to the $^5/_8$ in. vernier commonly used. Thus, the verniers that read to $^1/_{1,000}$ in. on the English scale and to $^1/_{50}$th of a millimeter on the metric scale may be quickly read without the necessity of removing the gage from the work and holding it up to the eye or employing magnifiers.

The graduations are made on a heavy triangular beam and the quick adjustment is obtained by simply pressing two lugs. The fine adjustment is so designed that the downward pressure in making adjustments on the screw, instead of causing tilting and unintentional moving of the height gage helps in holding the tool even more firmly to a surface plate.

The gage is hardened and ground all over and has accurate graduations. A master gage block for checking vernier setting and a depth rod for taking depth measurements are provided. In addition to the new 48-in. size, the gage is manufactured in 12-, 18-, 24-, and 40-in. sizes, with both English and metric scales. The George Scherr Company, New York.

SGU1-19 Utility Glider

Schweizer Aircraft Corporation has started deliveries of its single-place utility glider known as the SGU-119. The new glider is credited with excellent flight characteristics. It has a wing span of 36 ft. 8 in.; empty weight is 320 lbs.; the gross weight is 550 lbs.; and the normal wing loading is 3.23 lbs. per sq.ft.

Pilot protection is afforded by the sturdy fuselage of welded chrome-molybdenum tubing. Fairing is of steel and aluminum tubing, and the whole structure is fabric-covered. The wings, of two-spar strut-braced design, are of wood construction with aluminum covering the leading edges. The tail surfaces are of Dural and steel, fabric-covered. The pilot's seat is adjustable, with three positions to allow for differences in the weight of pilots.

Besides the ready-to-fly models of the SGU-119, this glider is being manufactured in kit form for schools and other groups having proper facilities for assembling aircraft. Vocational-training and industrial-arts instructors believe the glider can be assembled during normal shop class periods in one school year. Then, after the glider is certified by C.A.A., it may be flown by student pilots under proper supervision. Schweizer Aircraft Corporation.

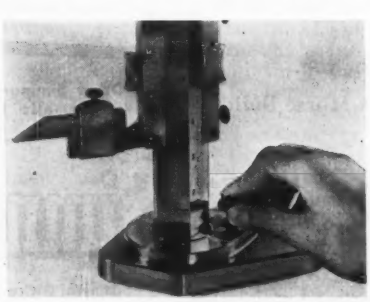
S-51 Helicopter for Commercial Use

The first helicopter to be offered for commercial use—the four-place Sikorsky S-51, commercial model of the Sikorsky aircraft—has undergone the final phases of testing preparatory to public demonstration and sale. It is expected that deliveries of the S-51 will begin early this summer.

The S51 follows the basic design and construction of the Sikorsky R-5, largest and most powerful of the three Sikorsky production models built in quantity during the war. However, its cabin is luxuriously appointed. The passenger seat comfortably accommodates three passengers. There is ample leg room. Unobstructed vision at both sides and in front is provided by the use of Plexiglas of high optical quality. Equipment can be incorporated for such special uses of the craft as pipeline and similar maintenance, shuttle service, crop dusting, fire fighting, insect control, and others.

To carry its useful load of 1,250 lbs., the S-51 employs a three-bladed main rotor of 48-ft. disc diameter. The overall length with blades extended is 57 ft., and the height is 12 ft. The helicopter is powered by a Pratt & Whitney Wasp Junior engine of 450 hp., giving sea-level speed of 103 m.p.h., with a cruising speed of better than 80 m.p.h. A cruising range of approximately 240 miles is provided by the fuel capacity, 100 gal., which is augmented by reserve fuel facilities.

The S-51 has a service ceiling of 13,000 ft., a hovering ceiling of 3,500 ft., and it will climb at the rate of 1,200 ft. per min. at sea level. Sikorsky Aircraft Division, United Aircraft Corporation.



George Scherr Company's Chesterman height gage.

New British Commercial Flying Boat

A new air liner, the Solent, developed from the Short Seaford military flying boat, with an operating range that brings the North Atlantic route within its compass, is being built for British overseas air services. Twelve of the planes have been ordered, and the first will be completed in the near future.

The estimated total weight of the Solent is 75,000 lbs., but this is likely to be increased. There is accommodation for 24 passengers day-and-night or, alternatively, 36 day passengers. The six cabins, four of which are on the lower deck and two on the upper deck, can each carry six day passengers or four night passengers. When 24 day-and-night passengers are carried, the cabins on the upper deck are used as a lounge and dining room. The crew of five consists of two pilots, navigator, radio officer, and flight engineer; there is also accommodation for two stewards.

More than 3 ft. longer than the Sunderland, the Solent is 89 ft. $6^1/_2$ in. in length, has a span of 112 ft. $9^1/_2$ in., a height of 37 ft., and maximum beam of 10 ft. $9^1/_2$ in. Wing area is 1,687 sq.ft.; wing loading, 44.5 lbs. per sq.ft.; and aspect ratio, 7.53.

Powered by four Bristol Hercules 130 air-cooled radial engines, giving 1,675 hp. per engine for take-off, the Solent has a maximum speed of 236 m.p.h. at 7,000 ft. The Society of British Aircraft Constructors, Ltd.

Three-Core Solder

Tri-Core is a solder with three independently filled cores of pure rosin flux. This new product is credited with offering users faster soldering and elimination of dry joints, in addition to substantial savings in tin.

A continuous supply of high-grade noncorrosive rosin flux is always present in the solder, since the three cores are completely independent of each other. With these three cores, occurrence of "dry" sections in more than one core at a given point is unlikely. It is stated that the new solder offers the proper fluxing that is vital to good soldering. The arrangement of the three cores places them closer to the surface. Since the walls are thinner than those of single-core solder, the solder melts more quickly, and the heat penetrates to the flux more rapidly, allowing it to flow freely and reach the work ahead of the molten solder. Careful cross-sectional proportioning and the absence of surface seams prevent premature sweating out of the flux, making it clean to handle at all times.

Tri-Core solder is reported to exceed A.S.T.M. Class A specifications. It is available in all alloys, all flux percentages, and all gages. Solder Development Division, Alpha Metals, Inc., Brooklyn.

Hopper Saves Assembly-Bench Space

A hopper developed for use with Stackbin assembly bins is reported to increase the capacity of the assembly bin

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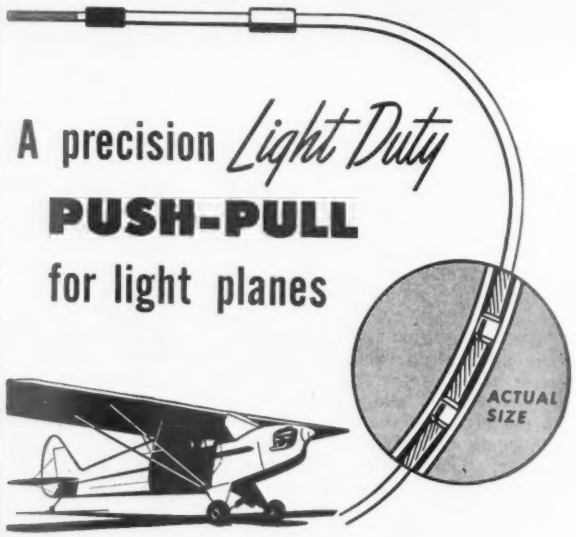
A precision *Light Duty* PUSH-PULL for light planes



Now—simpler, lighter, less expensive push-pulls are available under the Simmonds name, with the same plus qualities of the famous Simmonds controls. The Light Duty type, being precision-built, offers many advantages. In the unique patented sliding member, or linkage, swaged phosphor bronze bearing rings girdle the flexible steel cable at ⅝" intervals, reducing friction and giving added strength. In compression, these rings hold the cable compactly and enable it to stand a thrust up to 20 pounds. For heavier loads, Simmonds Standard push-pulls are recommended.

A "natural" for light plane installations on engine throttle, parking brakes, etc., the Light Duty push-pull can detour through structural jungles, save installation time because it is pre-formed and pre-assembled, and absorb vibration in use. It is available with rigid or flexible casing and a variety of accessories.

The Simmonds Push-Pull Control Systems now cover virtually every load requirement from 1 to 60 pounds. Nearly a million sets have given outstanding service on military and commercial aircraft. Write today for additional information, or submit your problem for free engineering analysis.

DATA FOR DESIGNERS

Load—Up to 20 lbs. in compression; heavier in tension.
Weight with rigid tubing—0.1 lbs./ft.
Outer diameter—¼" for rigid tubing.
Stroke—Up to 5"; longer on request.
Exceeds AN test requirements.
To order: Submit plan and side elevation sketches of principal dimensions, showing necessary bends. Templates of bent ¼" rod may be used for quotations or for prototype installations.

Other Simmonds Products: Pacitor (Electronic) Fuel Gauges—Automatic Engine Controls—Spark Plugs—Hydraulic Accumulators—Aneroid Capsules—Fasteners and Clips

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Montreal, Canada—New York, N. Y.

nearly four times, saving bench space and reducing costly interruptions in assembly work. Nesting together like the bins, they taper toward the front so that when set up they are in the form of a conveniently accessible semicircle. Sloping floors feed parts continually toward the front.

The equipment is made of heavy-gage sheet steel, with welded construction throughout. Finish is baked-on olive-green enamel. Attached to the assembly bin, it will remain rigid and nests securely without the use of any tool or fastening device. Consequently, it can be easily and quickly removed when a change is made in the setup on the bench. Assembly bins can be stacked above the hoppers, to keep the setup within convenient reach. Particular care was taken in designing this new hopper to avoid interference with hand motion and to control the flow of parts into the forward section of the bin. Stackbin Corporation, Providence, R.I.

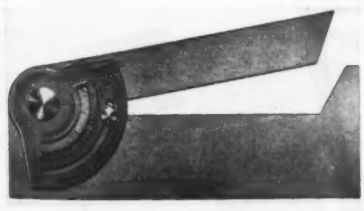
Resistance-Welding Tips

A company specializing in the production of molded composition metal, carbon, and graphite products, Stackpole Carbon Company has announced the addition of a line of resistance-welding tips. Two general grades, known as RW-1 and RW-2 are the direct result of wartime research and are now being made available to industry in general. Characteristics include excellent heat and electrical conductivity. It is claimed that use on difficult spot-welding applications has proved the ability of these tips to retain their hardness under severe conditions.

Both materials can be supplied in practically any required shape or size and are furnished to the usual tolerance. In addition to the standard types, RW-1 and RW-2, there are resistance-welding tips for specific requirements. Stackpole Carbon Company, St. Marys, Pa.

Adjustable Quadrangle

The S & J adjustable quadrangle is a plastic drafting tool combining many features not usually available in one instrument. Angles from 0° to 90°, pitch scales from 0 to 24/12, percentage slopes from 0 per cent to 100 per cent, and sine or cosine functions and tangents may be found by the use of the instrument. It has eight drawing edges, is rectangular in shape, and may be used as a triangle. Draftsmen, engineers, artists, designers, architects, and students will find the body and arm of the instrument blank so the owner may add his own most-used cutout symbols and measuring scale. The overall size of the drafting tool is 4 by 11 in. Stewart-Jackson Instrument Company, Los Angeles.



The Stewart-Jackson adjustable plastic quadrangle.

Radio-Noise and Field-Intensity Meter

The Stoddart Model NMA-4 noise and field-intensity meter, with single-band frequency range of 100 to 400 megacycles, is offered for locating and indicating in microvolts the amplitude of radio noise causing disturbance to radio reception in aircraft or other receiver locations. It is also intended for use in determining the effectiveness of filtering and shielding electrical apparatus that produces radio noise at ultra high frequencies and for indicating and recording in microvolts per meter the field intensity of amplitude-modulation, frequency-modulation, and television transmitters.

The radio-frequency amplifier, mixer, and oscillator circuits use "butterflies," which vary capacitance and inductance simultaneously, giving noiseless tuning because of absence of sliding contacts. These circuits maintain a high degree of stability and nearly constant value of resonant impedance which provides for substantially uniform calibration. Stability of calibration is determined by "shot noise" developed in the plate circuit of the radio-frequency amplifier.

The voltage range is 1 to 100,000 microvolts. Field-intensity range is 5 to 100,000 microvolts per meter. Performance and construction specifications are in accordance with Government requirements. The instrument is designed for portable or laboratory use, operating on 105 to 125 volts a.c. Its size is $15^{3}/_{16}$ in. high, $21^{1}/_{2}$ in. wide, and $14^{9}/_{16}$ in. deep; the weight is 56 lbs. Accessories are provided for inductive, conducted, and radiated-energy measurements. Stoddart Aircraft Radio Company, Hollywood, Calif.

Pocket-Size Pipe Gage

The Three Point pipe gage is so calibrated that, when placed against a piece of pipe or conduit, it registers the exact size by which it is known to the trade and not the outside diameter. It will measure all pipe, electrical metallic tubing, or conduit of sizes from $^{1}/_{8}$ to 12 in., inclusive. The gage measures pipe in any position, even if the pipe is against the wall, and will measure asbestos-covered pipe by placing the gage between the covering joints or in a small opening near a union or other fitting. In dark places, the gage can be placed against the pipe, then carried to the light and read. When closed it measures $2^{3}/_{4}$ by $4^{1}/_{2}$ in., weighs 2 oz., and can be carried in a pocket. It has a black electro rustproof finish, with etched numerals that are filled in with white enamel. Three Point Gage Company, Chicago.

Milling Cutters with Carbide-Tipped Inserted Blades

The manufacturer of the new "Vibra-Cushioned" face milling cutters with carbide-tipped inserted blades states that they combine the advantages of both inserted-blade and fixed-blade type of cutters for steel milling. Another advantage claimed is the ability of the new cutters to resist vibration, regarded as the most destructive element to carbides in the machining of steels.

Actually, the cutters are double-cushioned to decrease vibration. In the first place the carbide tips on the blades are extra thick in order to give maximum strength. Next, a round type of steel blade, providing more effective backing for the tip, is used. The blade is wedge-locked into a cutter body, which, in addition to being slightly heavier than conventional milling cutters as to total weight, has the weight distributed in such a manner as to provide the maximum of "flywheel' effect, contributing to smoothness of cutting action.

Use of inserted round blades, moreover, has made it possible to design the cutter body without external slots. Elimination of these slots, with their tendency to let the blade "give" under pressure, is said to impart a high degree of rigidity.

Despite these new features, the cutter is simple in design. Use of a wedge lock for individual blades, together with a screw adjustment at the base of the blade, permits fine adjustment of the blade as to height above the cutter body. This elimination of the usual "steps" in the adjustment of inserted blades decreases the amount of grinding of the carbide on the face of the blade necessary to bring any given blade to correct height. The design also simplifies the job of grinding blades to correct shape, while the construction of the cutter eliminates danger of runout. With this construction, uneven tightening of wedges has no effect on the accuracy of the cutter, since tightening of the wedge does not change its position or distort the outside diameter of the cutter body.

The new cutters are produced at present only for National Standard drive. Four standard sizes—6, 8, 10, and 12 in. in outside diameter—are offered, each in both left- and right-hand types. Blades are designed specifically for each size, and both blades and cutter bodies are carried in stock. Six-inch outside diameter cutters are designed for drive through keys, while larger cutters are designed for bolting to milling machine spindles, being counterbored to fit over the spindle. Tungsten Carbide Tool Company, Detroit.

Complete Gage Sets in Cabinets

Complete standard gage sets housed in durable cabinets are now available. Cabinet No. 500 contains 471 gaging members, sizes 0.030 to 0.500 in. in increments of 0.001 in.—each member with its own plastic collet—seven new

Bake in a Hot Oven . . . 1,950°F.

These red hot "cakes" are partially drawn stainless steel kettles that have just been annealed prior to further deep drawing. Strong, corrosion-resistant, and easy to clean, the kettles are of the type used extensively in hospitals, restaurants, and other institutional kitchens.

The ease with which stainless steel can be fabricated by the usual shop methods—such as casting, deep drawing, and welding—is one of the many reasons why it is so often specified where there is a need for equipment that is strong, tough, and has good resistance to rust and corrosion.

Other uses of stainless steel are described in ELECTROMET REVIEW, published by ELECTRO METALLURGICAL COMPANY, a Unit of UNION CARBIDE AND CARBON CORPORATION. ELECTROMET does not make steel, but produces the ferro-alloys used in its manufacture. If you need this complimentary publication, write to ELECTRO METALLURGICAL COMPANY, 30 East 42nd Street, New York 17, N. Y.

lightweight handles, and four drifts to fit all size ranges. All equipment needed for cylindric plug gaging in the specified range is at hand in the three-drawer cabinet. Gaging members are progressively stored, each in its own receptacle. The size of the gage is stamped on collets to facilitate selection. Cabinet No. 600 contains 501 gaging members in four drawers—sizes are 0.500 to 1.000 in. in increments of 0.001. Plastic collets are included for each pin as well as four of the new lightweight handles and four drifts to fit all size ranges.

These cabinets are designed for toolroom service. Sliding drawers are double-suspension type, equipped with ball bearings and tumbler lock. Gaging members are available in XX, X, Y, Z, and ZZ tolerances, finished by lapping or chrome-plating and lapping. United Precision Products Company, Chicago.

Test for Explosion-Resistant Motors

A test setup involving the creation of sparking in small motors sealed in a tank filled with 100-octane gasoline fumes was devised during the war to satisfy the Army Air Forces that specially designed explosion-resistant motors could operate in airplane compartments that had become gas-filled without causing explosions that might destroy airplanes and their crews.

Explosion-resistant motors are so designed that any openings in the shell are extremely narrow and with paths long enough so that, in traveling them, burning gases are cooled below the ignition point and snuffed out. Tolerances of bearings and shafts are close, and the few openings in the motor shell may be zigzagged in order to make a longer path for cooling.

In order to test the efficiency of design of the explosion-resistant motor, it is placed in a chamber or tank, which is then sealed. Below the tank, the explosive 100-octane gasoline is placed in a smaller tank connected with a blower. The blower vaporizes the gasoline and forces the fumes through two small pipes, one of which is attached to and delivers the fumes inside the motor. The other pipe forces the gasoline vapors into the chamber surrounding the motor. Then the gas inside the motor is ignited by firing a spark plug previously fitted into the shell. The mixture inside the motor could be ignited by merely running the motor, but the explosion occurring is so small that it could not be heard if the motor were running. Designs worked out to meet such wartime aircraft requirements are expected to contribute greatly to the safety of peacetime air-line and private aircraft. Westinghouse Electric Corporation.

Wyco Hy-Speed Saw Speeds Production Work

The Wyco Hy-Speed saw embodies modern features for fast and dependable work. Attached to any 1/4-in. electric drill, air drill, or flexible shaft, it saws and files metals, wood, or plastics. It uses ordinary hack saw blades and standard 1/4-in. shank machine files in chuck or collet. True sawing is reported to be assured by a new square plunger with take-up for wear. All rotating parts are ball bearing, running in oil. There are no gears and no cams. All bearing parts are heat-treated. Wyzenbeek & Staff, Chicago.

House Organs and Catalogues

(*Continued from page 93*)

Functions and Use of the Machometer

Measuring Compressibility Effects with the Mach Meter. In a 4-page folder it is explained how compressibility effects are measured by means of the Mach meter. The design, characteristics, operating principles, and application of the Mach meter are outlined. *Taller & Cooper,* Brooklyn.

Manufacturing Jet-Engine Components with Hydraulic Presses

H-P-M Fastraverse Presses Produce Parts for "Jet" Airplane Engines. This is an account of how Fastraverse presses are employed by the I-T-E Circuit Breaker Company to draw and form component parts for General Electric jet aircraft engines. Besides describing the design and operation of the two presses used, the article outlines the procedures by which the parts are produced. *The Hydraulic Press, No. 38.*

Fabricating Aircraft Cable

Tendons of Stainless. Brief notes tell how stainless-steel aircraft cables are produced by the Macwhyte Company. They also describe the nature and types of cables fabricated by this company. Three principal types of construction are stressed: the 1 by 19 construction, made of 19 wires; the 7 by 7, containing 49 wires; and the 7 by 19 design having 133 strands. *Steel Horizons,* Vol. 8, No. 1.

Resistance Components

Ohmite Riteohm Precision Resistors. Recommended by the manufacturers for use in voltmeter multipliers, laboratory equipment, radio and electrical test sets, attenuation pads, and electronic devices requiring accurate resistance components, a line of noninductive pie wound resistors is described and illustrated. Types particularized are Series 82, 83, 84, and Type 81—consisting of specially enameled alloy resistance wire on nonhygroscopic ceramic bobbins; Type 71—single-layer wound, low-inductance vitreous enameled units; and Series 90—hermetically glass sealed noninductive units. Tables list the maximum voltage and the list price of each. *Ohmite Manufacturing Company,* Chicago.

Indicator Lights

Gothard Indicator Light Assemblies for Panel Board and Instrument Signaling. A series of indicator light assemblies for panel board and instrument signaling is listed in Catalog No. 46. Specifications accompany the illustrations and descriptive data for each. Included among the units shown are indicator lights with Lucite caps; 1-in. indicator lights of various types; bayonet-socket indicator lights; threaded jewel holders with 1-in. jewels; variable light-intensity indicator lights; assemblies with wide-angle, light-diffusion lenses; and jeweled horizontal mountings of differing sizes and kinds. Others are dial-light bracket assemblies; various jeweled vertical-mounting types; and jewels for separate mounting in panels.

General scientific data relating to pilot lights are offered in the catalog. *Gothard Manufacturing Company,* Springfield, Ill.

Stainless-Steel Data Sheets

Allegheny Ludlum Blue Sheets. There are now available new "Blue Sheets" of reference data on Allegheny stainless-steel castings, stainless Types 347 and 321, Type 416, and Ludlum 609 shock-resisting steel for tools and machine parts.

These file-size sheets contain reference data certified by the corporation's technical staff and prepared from carefully checked laboratory and service tests. Physical properties, corrosion and oxidation resistance, effects of elevated temperature, and heat-treating procedures and results are included in condensed form for quick reference. *Allegheny Ludlum Steel Corporation.*

Production and Maintenance Suggestions

United Air Lines News, February, 1946. A plan for improved airplane navigation lighting provides that aircraft lighting be arranged so as to give a definite color pattern to aid pilots of other craft in identifying and determining the direction of the plane's flight at any approach angle; and that lighting be increased in intensity and adequately directed to warn approaching pilots.

Pan American Clipper, February, 1946. (1) Jig for relocating cowling ring attach brackets; (2) use of a stand drill as a radial drill to make holes anywhere in any size panel; (3) fuel-dump valve testing attachment.

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The ARMCO Distributor in this three-cornered team is a good man to know. He has the stainless steel stocks and delivery service; you have the skill and experience in making aircraft parts, and we produce a wide range of stainless steel sheets and strip.

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This rustless steel forms readily and can be joined by the fast, economical spotweld process. No heat treatment is needed to develop physical properties.

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